Sky and TELESCOPE

New French Observatory

Vol. IV, No. 9
JULY, 1945
Whole Number 45
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French Astronomy During the War Years
Eclipse Chatter
Stars of Summer
Eclipses and Earth Surveys
Northern and Southern Star Charts

The Editors Note

WITH this issue we conclude our advance coverage of the July 9th eclipse. For your quick reference, and for recent subscribers, the following list may be useful. January, 1945, is Whole Number 39.

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We hope that much of this information has been of interest to you, whether you are traveling to the eclipse in actuality or vicariously. If you must be an armchair eclipse observer this time, keep June 20, 1954, open, and the path of totality through Minnesota, Wisconsin, and Ontario can be lined with eclipse observers then!

Sky and TELESCOPE

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In Focus

ALTHOUGH it is often said that the North America nebula, pictured on the back cover this month, is an object which only long-exposure photographs can reveal, it received attention from Sir William Herschel, who observed it as a diffused nebulosity in the Milky Way. E. E. Barnard, famous observer of the Milky Way, says further of it, "The first photographs of it which showed its singular form were made by Dr. Max Wolf, who happily named it the 'North America Nebula.'"

This month's back cover was photographed at the Hamburg Observatory station in Bergedorf by Bernard Schmidt, of Schmidt camera fame. It was made on December 21, 1932, with a 1¼-hour exposure, using, as the photographic data reads, "the B. Schmidt coma-free reflector of 36-cm. aperture and 62.5-cm. focal length, f/1.75."

The nebula, whose 1945 position is $20^h\ 56^m\ 50^s$, $+44°\ 06'.4$, shows masses of dark nebulosity on what we may call the Pacific side, and bright detail in the Atlantic. The Isthmus region has been described as full of interesting detail, and showing a marked cutting off of faint stars on each side. The Canada region is a mass of diffuse nebulosity with no detailed structure. The entire field contains dense clouds of faint stars.

The North America is a fine example of an emission nebula, and the surrounding obscuration is among the densest of the nearer dark nebulae, estimated to be about 500 parsecs distant, and dimming the light of more distant stars by four magnitudes. The Great Rift, producing the two branches of the Milky Way stretching through Cygnus, Aquila, Ophiuchus, Scutum, Scorpius, and Sagittarius, may be considered to begin with the Gulf of Mexico obscuration in the North America nebula.

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BACK COVER: The North America nebula in Cygnus, photographed on December 21, 1932, by Bernard Schmidt, at Bergedorf. (See In Focus.)

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French Astronomy During the War Years

The March, 1945, number of the *Astrophysical Journal* carries a translation of a report by Bernard Lyot, outlining his planetary and solar observations on the Pic du Midi in 1941, 1942, and 1943; a report on the activities of Meudon Observatory since 1940, by L. d'Azambuja; and a series of Lyot photographs of solar phenomena and pictures of the new observatory in southern France by D. Chalonge. These were made available by Gerard P. Kuiper, of Yerkes Observatory, who early in the year was able to visit some French astronomers when he was on the Continent during a wartime mission.

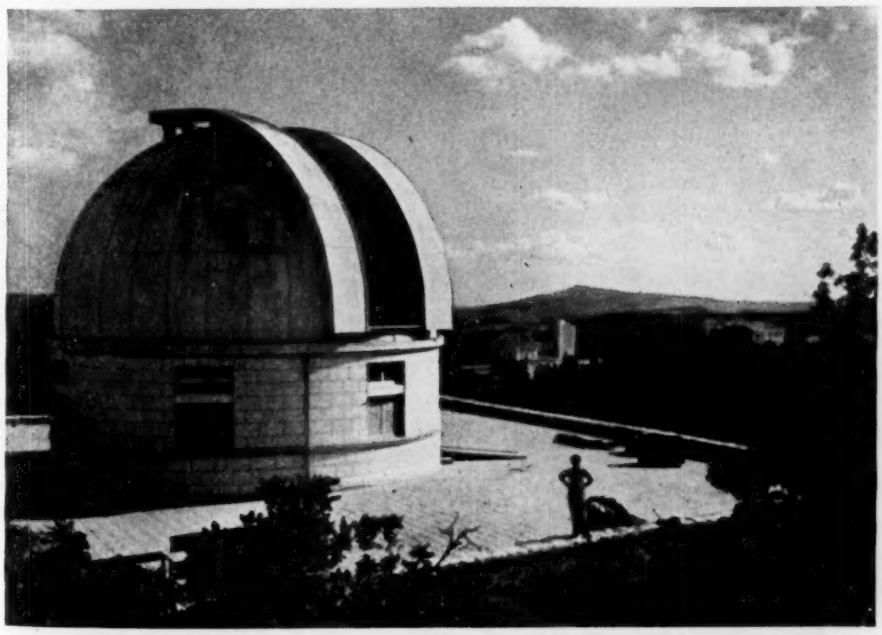
The publishers of the *Astrophysical Journal* have generously lent the engravings selected for republication here; Dr. Kuiper furnished the front-cover picture and some information contained in this account, most of which, however, has been extracted directly from the reports by Lyot and d'Azambuja.

The 120-cm. reflector of the St. Michel Observatory, with an observer at the Newtonian focus. The wooden casings on the frame of the tube have since been removed.

AT AN elevation of 2,000 feet above sea level, and situated near the Durance River about 60 miles northeast of Marseille and 35 miles east of Avignon, is the new French observatory pictured on the front cover and in the accompanying illustrations. It is near the town of St. Michel, Haute Provence, and only three miles southwest of Forcalquier, where one of its instruments, a 32-inch reflector, was formerly housed. The largest telescope at this new observatory, however, is a 48-inch reflector. This is the same 120-cm. instrument which was rumored to have a diameter of 120 inches, that error occurring at a time when our communications with France were very poor. (See *Sky and Telescope*, May, 1944, page 9, and July, 1944, page 7.) A quartz f/2 nebular spectrograph is another important instrument at the St. Michel Observatory.

The new observatory operates under the auspices of the French *Centre National de la Recherche Scientifique*. Dr. J. Dufay is the director, but at present, with the observatory project not entirely completed, Charles Fehrenbach, formerly of Strasbourg, is in charge of actual operations.

With the exception of the Jewish astronomers, the French have been able to carry on after a fashion. In addition to the near completion of the new observatory, they have been able to finish the Institut d'Astrophysique in Paris, except for the interior of some of the offices.

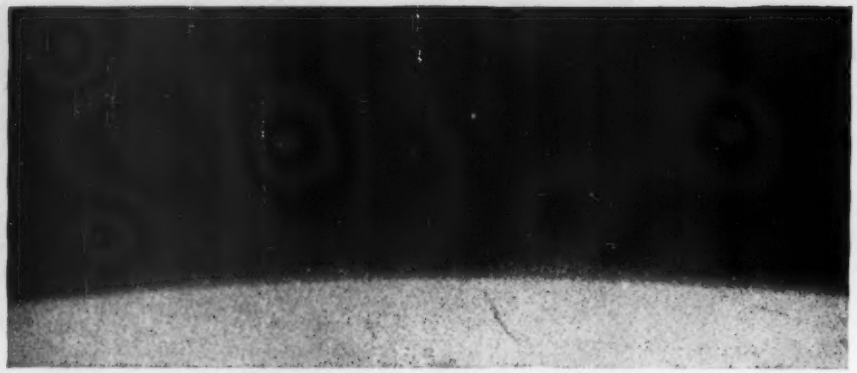


The dome of the 120-cm. reflector, which appears in the distance in the front-cover picture. Here the astronomer's residence is seen in the background.

At Meudon Observatory, the optical parts of the various telescopes were dismounted and placed in safety at the beginning of the war. Only the spectroheliograph, housed under a strong roof, remained in use. This instrument has been used for regular routine solar observations. Meanwhile, Mr. and Mrs. L. d'Azambuja have studied the evolution of solar prominences and their movements, utilizing observations of the years 1919 to 1937. They conclude that about half of all prominences apparently originate in the faculae region accompanying sunspots and drift from these toward higher latitudes, but it also seems possible that the filaments identified as prominences do not become visible on the surface of the chromosphere until about three quarters of a solar rotation after they have formed simultaneously with the spots themselves.

For as many as five solar rotations the prominence filaments persist, reaching their greatest development at about the third turn, the study showed. The prominence filaments move steadily toward the pole, about 1.3 degrees of latitude per rotation; long-lived filaments may even reach polar latitudes, and it may be that polar filaments are the remains of those formed nearer the solar equator.

Prominences not associated with faculae seem to follow the same rule



The sun's chromosphere appears as a dark layer above the photosphere. This picture is taken through a monochromatic filter centered on hydrogen alpha in a band 1½ angstroms wide. The exposure was 1/40 of a second. The diameter of the sun's image is one meter; scale of the picture is nearly 22,000 miles to the inch.

of change of latitude during the 11-year cycle as do sunspots themselves, suddenly appearing in high latitudes at the start of a new cycle.

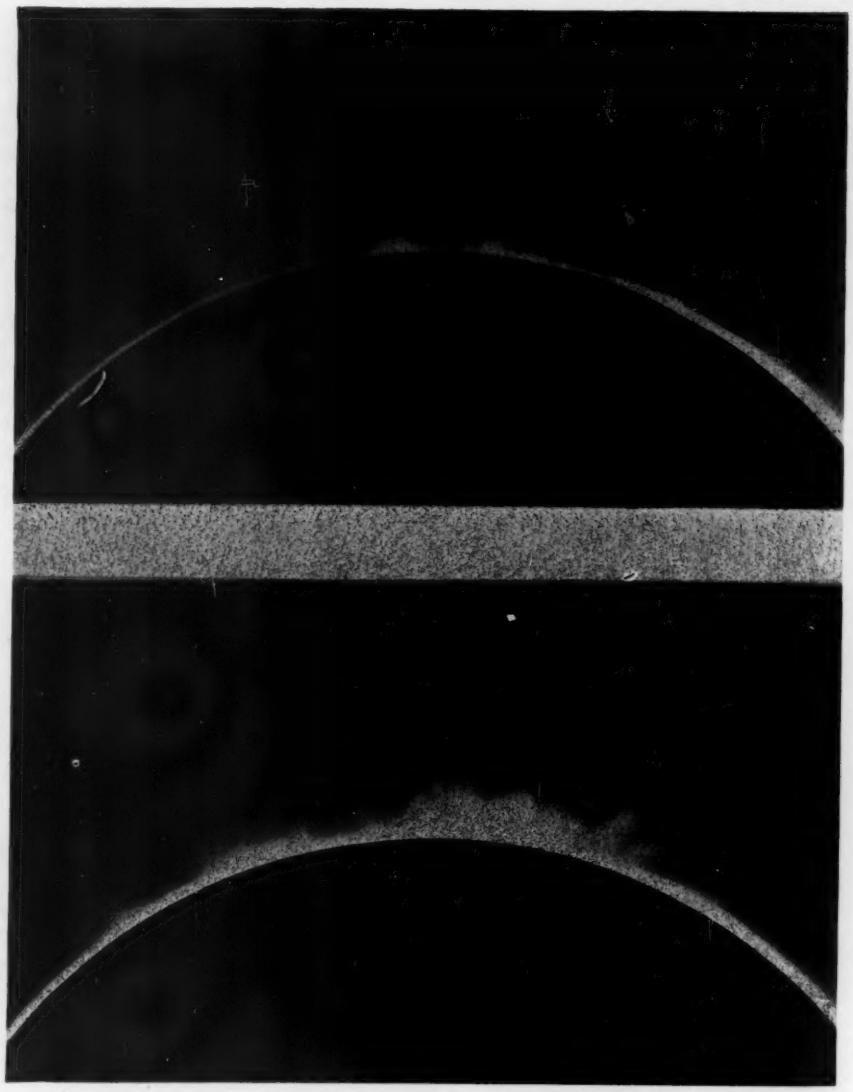
Other researches carried on or completed during the war include detailed study of internal movements in solar prominences, by M. Pan-Puh, a Chinese astronomer who studied at Meudon from 1936 to 1940. F. Baldet made numerous observations of Mars in 1941, and has written monographs on several comets. M. Bertaud has worked on magnitudes and color indexes, and has compiled a catalogue of 36 supernovae. He has confirmed and extended the empirical relation found by D. B. McLaughlin to exist between the rate of decline of a nova's brightness and the velocity of expansion of various shells of gas emitted by the nova. The maximum absolute magnitude of ordinary novae he finds to be about —7.

By far the most striking results obtained by French astronomers during the war are those by Bernard Lyot and his collaborators on the Pic du Midi. The coronagraph has an aperture of about eight inches and a focal length of over 13 feet, and is used with a polarizing monochromatic filter (similar to the monochromator described on page 6, *Sky and Telescope*, February, 1945) in which polaroid layers were replaced in 1941 by spar polarizers. This gave increased transparency to the filter and for various other reasons increased the definition of the images, bringing out many details in the corona.

The light of the sun's corona is principally emitted in two wave lengths, 6374.5 in the red, and 5302.8 in the green region of the spectrum. The prominences, however, radiate strongly in the light of the hydrogen alpha line. By Lyot's ingenious arrangement it is possible to record, on moving film, pictures of the corona in two colors, of the prominences in hydrogen alpha, and to use an eyepiece on a fourth image for guiding purposes. Plates on which the sun has a diameter of six centimeters require an exposure of seven minutes in the green and four minutes in the red; they bring out much finer structure and more contrast than when the total light of the corona is used. Such monochromatic pictures show that the color of the corona changes from red to green from one region to another.

Films covering a total duration of 92 hours fail to confirm actual motions in the corona reported by some observers. Lyot finds that even when speeded up 2,400 times, the corona remains stationary — no moving streamers are observed. The corona as a whole seems to pulsate, however, getting brighter and fainter over large segments; it is apparent, therefore, that radiation is the exciting source for the corona.

An east wind can, surprisingly enough, aid in procuring good pictures of the granulations in the sun's photosphere, usually referred to as forming the rice-grain structure seen in direct observations. During mornings in May, 1943, an east wind frequently blew steadily for about three hours,



The sun's corona photographed with the coronagraph in green light, exposure, seven minutes. The upper picture is of the west limb on September 14, 1941; the lower picture is of the east limb the next day.

directly onto the objective of a 9½-inch refractor, helping it to give remarkably sharp and steady images of the sun's surface. Seven films were taken, averaging three hours' duration each, six exposures to the minute; three of the films show the great activity of the grains, which are born and die in the course of a few minutes.

During the partial eclipse of September 11, 1942, under unfavorable atmospheric conditions, M. Gentili and Lyot obtained photographs of the corona showing it partially eclipsed by the moon. This achievement is significant in that it demonstrates how far the coronagraph has been developed in a little over 10 years; before Lyot built his coronagraph we had to wait for an eclipse of all of the sun before we could even hope to see the corona.

As for the chromosphere itself, pictures through special filters show it as a band at the limb of the sun varying in height from three to seven seconds of arc (each second is roughly 450 miles on the sun). On the disk, the chromosphere appears similar to hydrogen spectroheliograms, but with less contrast. The filaments are strongly visible, and near groups of active spots there are a great number of chromospheric eruptions, sometimes less than one second of arc in diameter. As many as 17 of these eruptions have been seen in an hour.

As such chromospheric eruptions usually first appear with large velocities in the line of sight, the Doppler effect shifts their radiation away from the wave length of hydrogen alpha, but by an elliptically polarized compensator, Lyot has been able to change the wave length of his filter as rapidly as the light of the eruption itself shifts.

For extensive work on the planets, in 1941 the Pic du Midi astronomers borrowed from the Toulouse Observatory a 15-inch refractor. An enlargement lens was used near the focus, and photographs of excellent quality were obtained. More recently, Lyot has worked with the 24-inch Coudé telescope (60-foot focus) of the Paris Observatory, also mounted on the Pic du Midi. With it he has obtained a number of excellent lunar photographs.

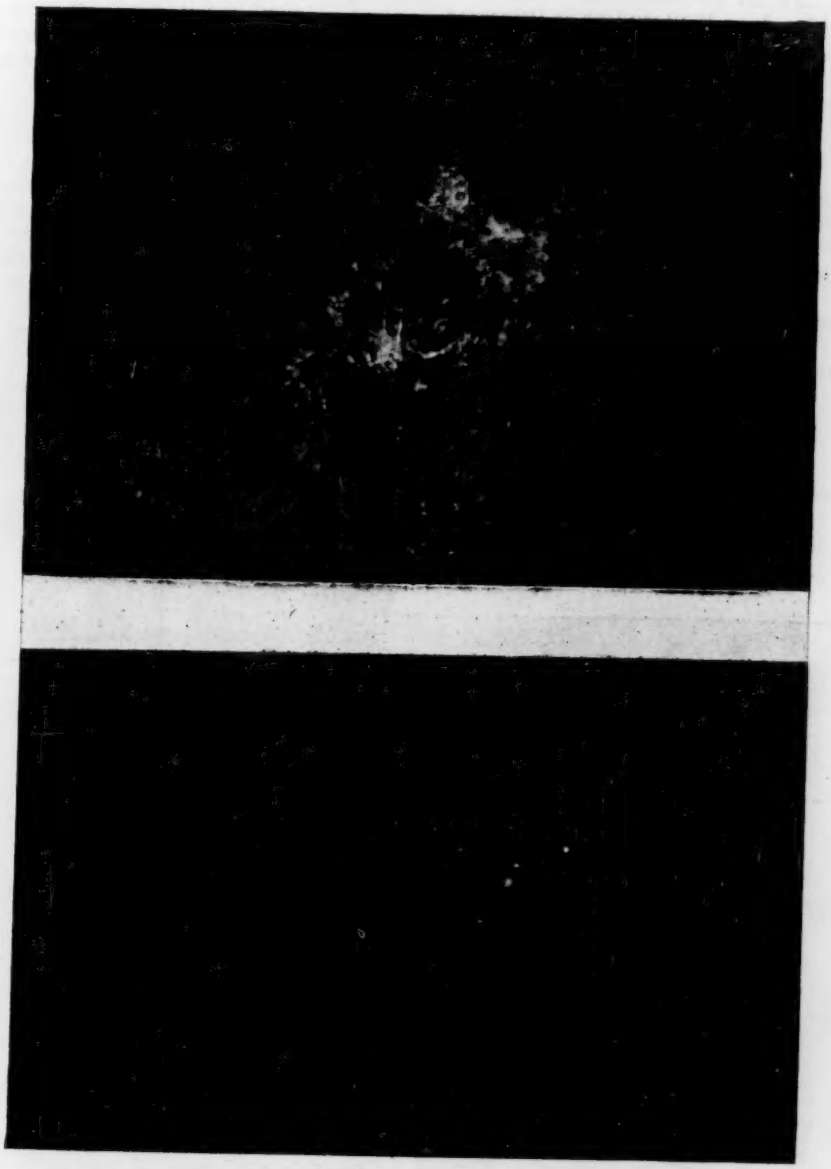
New details were observed on the surface of Mars at the time of its favorable opposition in 1941, and in 1943-44 photographs showed more numerous and darker "canals." Mercury was observed in conjunction, only 1° 40′ from the sun, and under a magnification of 500x the planet showed spots comparable with those of the moon seen with the naked eye. More was learned about the structure and transparency of the rings of Saturn.

Of especial interest are the observations of the planetary satellites. Polar caps and spots were found on Jupiter's four bright moons: dark poles and dark north-south bands on Io, bright poles and dark equatorial spots on Europa, a white polar cap and dark spots on Ganymede, and a bright south polar region and light spots surrounding the north pole of Callisto.

By comparing their images with an artificial disk, Camichel measured the angular diameters of these same satellites, with an error of about one per cent. Assuming them observed at a distance of five astronomical units, their diameters turn out to be:

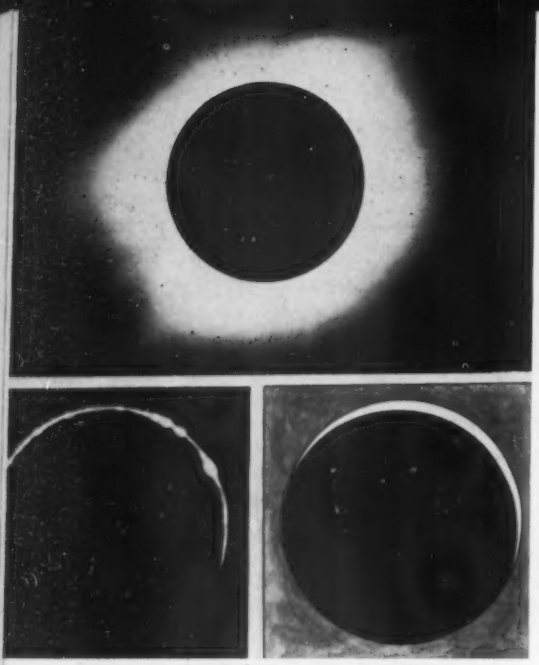
Satellite	*Seconds of arc*	*Kilometers*	*Miles*
I Io	0.914	3,310	2,060
II Europa	0.804	2,910	1,810
III Ganymede	1.380	4,990	3,100
IV Callisto	1.288	4,660	2,895

The apparent diameter of Titan, Saturn's brightest satellite, was found to be 0.750 seconds of arc, which, at Saturn's mean distance, would correspond to 5,180 kilometers or 3,220 miles. For Jupiter's moons, these values are smaller than previous estimates, and for Titan 20 per cent larger.



The upper picture is similar to a spectroheliogram, centered on the hydrogen alpha line, and shows the prominence filaments associated with a small group of sunspots. The lower picture shows the same region with the central wave length shifted one angstrom to the violet. The brilliant spot of light at right center is a small hydrogen eruption, moving upward from the sun's surface so fast its velocity in the line of sight has shifted the wave length of its light to the violet. Therefore, the eruption appears bright in this picture, which otherwise is an almost normal view of the sun's photosphere.

Eclipse Chatter



Those within the path of totality will see the sun's pearly corona, pictured at the top. Baily's beads, lower left, precede and follow totality, and are also seen by those at the edge of the path. The crescent at the lower right is a drawing of the partial phase, more than 90 per cent total.

TWO WIDESPREAD OBSERVING PROGRAMS

Advance announcements and instructions for observers participating in two different types of observing programs have already been sent out to a wide distribution of people. From Princeton, N. J., Dr. John Q. Stewart has sent questionnaires for persons wanting to help in observations of the moon's shadow and sky brightness during the eclipse. He has enlisted the co-operation of Forest Service lookout personnel near or in the eclipse path, and has sent the same material to schools, colleges, libraries, Weather Bureau stations, and a few military airfields. His program for observing is in line with the material of his article, "The Shadow of the Moon," which appeared in the May issue of **Sky and Telescope.**

Amateurs who will want to help Dr. Stewart with this observing program may get copies of the questionnaire from the Eclipse Secretary, 14 Prospect Avenue, Princeton, N. J. (You may wish to enclose postage for air mail return if the time is short.) Observations on this program will be of value whether or not you are in the path.

Dr Stewart, himself, will be located at Malta, Mont., with a party consisting, at least, of James Stokley, Dr. and Mrs. Ira M. Freeman, and William L. Hopkins, Jr., a V-12 student at Princeton.

The second program is for determination of the limits of the eclipse path. In organizing this, the editors followed the outline of a program proposed by Mrs. Isabel M. Lewis, of the U. S. Naval Observatory, who wrote the April article on "Eclipse Maps and Observing Hints." They have sent material to nearly 30 newspapers in Saskatchewan and western Manitoba, covering all the towns in or near the path where papers are published. A general story on eclipses and the partial and total phases of this eclipse was sent, together with simple instructions for observers near the limits of the path who do not plan to travel to the central line for observing. We have enlisted the co-operation of the newspaper editors in organizing a program in each community, which we hope will yield valuable data on the exact observed limits.

The editors will probably not be in Regina at all, contrary to the announcement in the June issue, but will travel instead direct to Melville, and from there to a point on the central line.

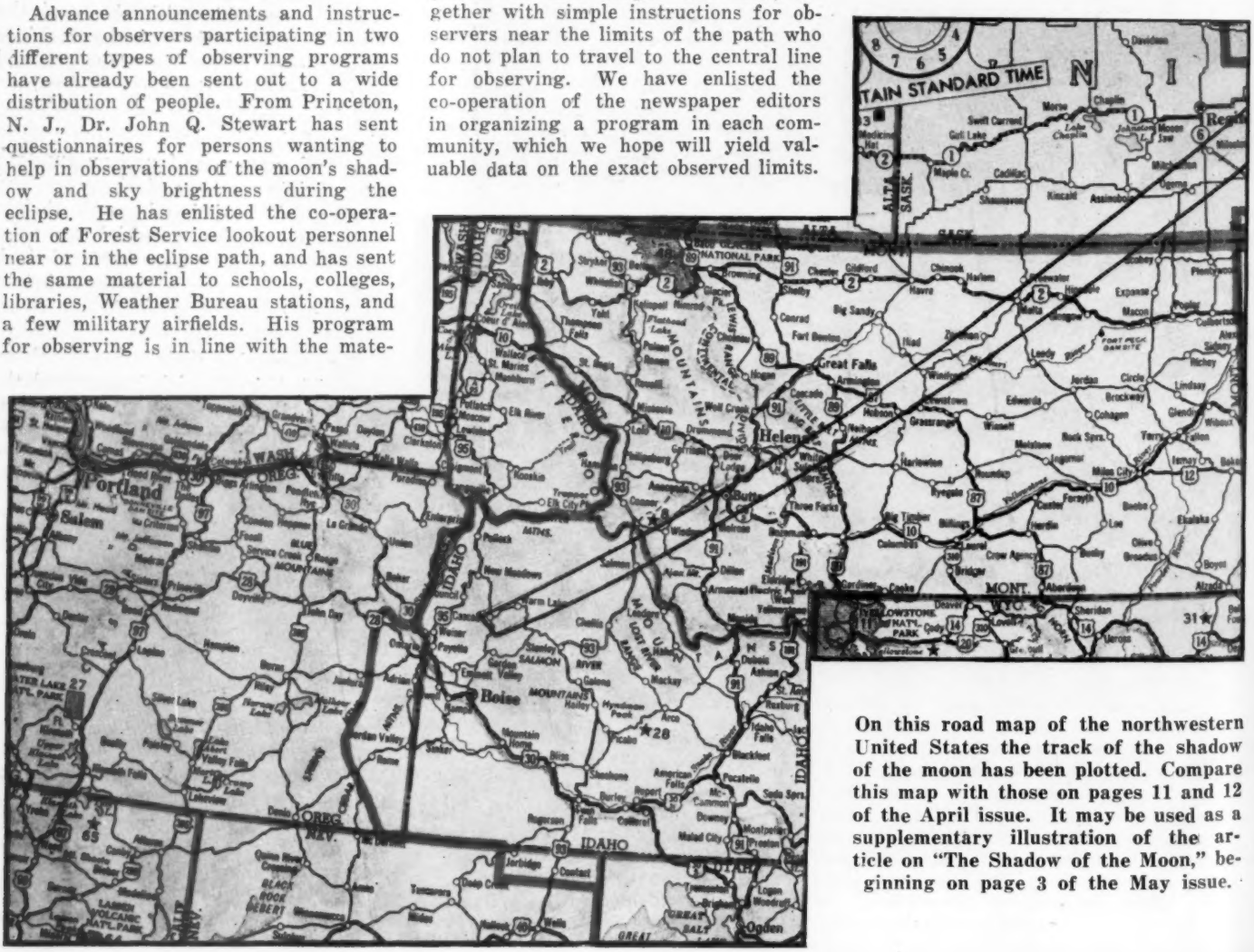
Just how successful these two widespread appeals to an unknown number of observers will be remains to be seen. We shall carry reports of results when they are compiled.

PERSONAL NOTES

A number of amateur astronomers, most particularly those in the northwestern and western parts of the country, have indicated that they plan to observe the eclipse, but at the time we go to press, many of them are not yet certain of their exact locations.

As a base for observing sites, Wolseley seems still to be the most talked-of town on the Canadian side of the border, and Malta and Opheim both are receiving their share of attention from people for whom time is a major consideration, and who cannot therefore go too far afield.

Dr. J. B. Bostick, of Fresno, Cal., has indefinite plans for going. Arthur W.



On this road map of the northwestern United States the track of the shadow of the moon has been plotted. Compare this map with those on pages 11 and 12 of the April issue. It may be used as a supplementary illustration of the article on "The Shadow of the Moon," beginning on page 3 of the May issue.

Butler, of New York City, will stop at Wolseley on his way to the Canadian Rockies. Arvid A. Hansen, from Rowan, Ia., plans to observe with camera and movie equipment. Jesse Ketchum, of Saskatoon, Sask., who has sent helpful information about the eclipse region, is scheduled to be at Roblin or near Melville. Lewis Lindsay, of San Francisco, plans to be in the eclipse path.

Albert V. Shatzel, director of the Mono Observatory at Coleville, Cal., writes that two members of the staff will probably be near Opheim, with some equipment, flying both ways to save transportation time. Carl P. Richards, of Salem, Ore., is going to Regina, and from there to some as yet undetermined place in the path. He may have several friends with him. From Billings, Mont., Beatrice Vogel and a few fellow students will travel to Opheim, or some other place probably in the Montana part of the path.

Members of the Winnipeg Centre of the R.A.S.C. who plan to go to Wolseley are Olive Armstrong, Margaret E. Watterson, and V. C. Jones. A. V. Thomas plans to go to Roblin, while L. T. S. Norris-Elye, director of the Manitoba Museum, our correspondent, hopes to observe from the Duck Mountain escarpment near Pine River.

A note in the Detroit **Free Press** reports plans by E. P. Holleran, Northwest A. S., Detroit, and Dr. W. Carl Rufus, University of Michigan, to fly to Hudson Bay. Mrs. Margaret Back, secretary of the Detroit A. S., is taking four high school students with her. She will probably observe from Wolseley with Detroit amateurs Mazer, Jones, and Hallam.

NEW YORK A.A.A.

Plans for a weekend plane trip to Butte, Mont., have been tentatively announced by the Amateur Astronomers Association, depending on the possibility of chartering an airliner, and on the number of people who will go. The schedule calls for flying direct from New York to Butte on Saturday, July 7th, and returning late Monday, July 9th. The announcement points out the possibility of flying above the weather, should clouds prevent ground observation of the eclipse. A plane flight enabled some 15 A.A.A. members to get a view of the annular eclipse from about 10,000 feet, in Florida in 1940.

ECLIPSE REPORTS

Where you were, who was with you, some data on your equipment and your observing program, the state of the weather, pictures you got, and any other facts of interest, will make good reading for the unlucky ones who had to stay home. Send the editors, immediately after the eclipse, a story of your expedition, whether it was large or small, successful or clouded out, for inclusion in our roundup of eclipse news in the August issue. This goes to press soon after we get back to Cambridge, so don't delay.

Amateur Astronomers

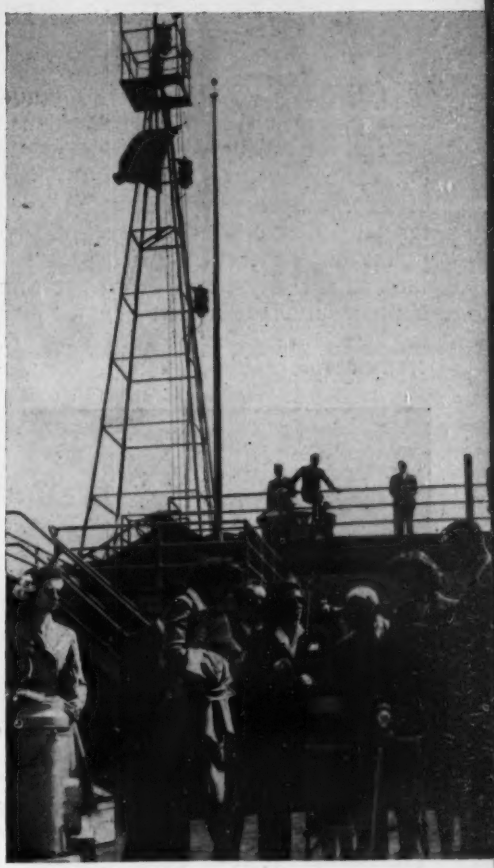
NEW YORK AMATEURS VISIT WEATHER BUREAU

Meteorologically minded New York A.A.A. members to the number of 35 got some authoritative, first-hand information on Memorial Day when they toured the U. S. Weather Bureau, located at the tip of Manhattan Island. Clear, blue skies and a dazzling sun dispelled any impulses the astronomers might have had to criticize the weather man, and the only protests heard were those raised when the brisk 37-mile-an-hour wind blew hats off.

In the Weather Bureau offices the group listened to a lecture by a staff member on the work of the bureau and the operation of its instruments. These included the barometer, anemometer (for wind velocity), psychrometer (humidity), maximum and minimum thermometers, sunshine tube, rain and snow gauges, the new radiosonde, and other necessary record-keeping devices.

A large wall map showing temperature and pressure conditions throughout the United States and Canada during a severe cold snap several years ago evoked many questions. After these were answered, the amateur astronomers went up on the roof of the building where they saw the weather instruments functioning, and then called it a perfect day.

JANE S. DAVIS
Staff editor, A.A.A.



Amateurs atop the Whitehall building examine the rain and snow gauges. The tower supports the anemometer and wind-direction vane; also seen are New York harbor guide beacons and the pennant warning small craft of Memorial Day winds.

NEARLY 200 BOLIDE REPORTS RECEIVED

Dr. Charles P. Olivier, president of the American Meteor Society, writes that although nearly 200 reports have been received on the startling meteor which exploded near Philadelphia the morning of May 4th, there is nothing authentic to add to the account appearing on page 10 of the June *Sky and Telescope*.

The entire area seems to have been so densely clouded that no matter which direction a window faced, a person inside saw brilliant light—the whole sky was very brightly illuminated. Three minutes for the sound to reach Philadelphia is a rough average, Dr. Olivier states.

There are a few reports from observers at a distance who seem to have seen the actual flight of the meteor, but reports are conspicuously absent from some parts of Pennsylvania and nearby states which should have had clear skies at the time. Perhaps observers on vessels along the coast, anywhere from New England to Norfolk, will send in belated reports of this meteor.

HOUSTON AMATEURS ORGANIZE

The Houston Astronomical Society has now been organized, with a membership of between 35 and 40, and prospects that it will grow. We meet on the last Friday of each month, at 7:30 p.m., in the Museum of Natural History Annex, Hermann Park; our meetings will probably be held all the year around.

We had planned to observe the Lyrid meteors, but the shower we observed was, instead, the more common, earthly type. The rain continued for two days.

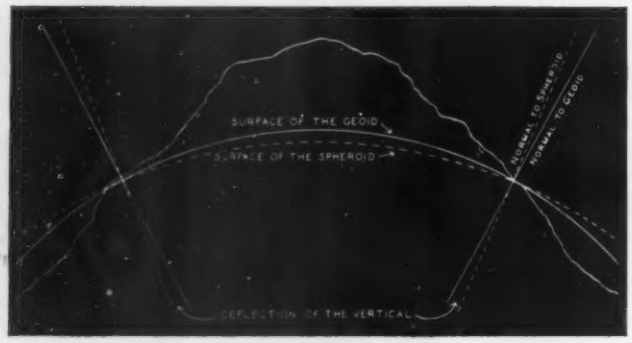
Persons interested in our activities are invited to communicate with the undersigned, who is secretary-treasurer.

NATHAN MIRON
4310 Elsbury
Houston 6, Tex.

ECLIPSES AND EARTH SURVEYS

By WALTER D. LAMBERT, *Chief, Section of Gravity and Astronomy, U. S. Coast and Geodetic Survey*

THE NEWS NOTE in the January, 1945, issue of this magazine, entitled "Eclipsed Sun for Earth Surveyors," suggests that observations of solar eclipses may be used to determine the distance between two points on the earth. This suggested method is really a new way of stating a procedure that used to be familiar to astronomers before the days of transoceanic cables, namely, the determination of difference of longitude by means of observations of solar eclipses or of occultations of stars by the moon. It may be of interest to examine the question from the point of view of an earth surveyor and to see how his problems tie in with those of the astronomer who is trying to keep tabs on the moon.



Under an island, the geoid has an upward bulge with relation to the spheroid. The angle between the respective perpendiculars to these surfaces is the deflection of the vertical. Adapted from U.S.C. & G. S. Special Publication No. 99.

The necessary formulas for deriving differences of longitude from observation of eclipses and occultations are given in Chauvenet's *Spherical and Practical Astronomy*. Let us examine carefully what kind of longitude—and what kind of latitude, for that matter—Chauvenet is really dealing with. We shall find that they are not longitudes and latitudes that the earth surveyor and astronomer can observe directly.

The latitude and longitude *directly observed* by the astronomer or the earth surveyor depend on the direction of the plumb line. The colatitude is the angle between the plumb line and the axis of the earth, that is, the axis of the celestial sphere; the difference of longitude is the angle between two planes, each determined by the direction of a plumb line and the direction of the earth's axis. These co-ordinates, depending upon the direction of gravity at each place on the earth, are usually called *astronomical* latitude and longitude. But Chauvenet's co-ordinates depend simply on position in the body of the earth referred to an axis and an assumed plane of the initial meridian. They have nothing to do with the direction of the plumb line, and are called *geodetic* or *geographical* latitude and longitude.

These co-ordinates of Chauvenet would remain the same if, as we may imagine for the sake of illustration, the earth were surrounded by a swarm of irregularly moving bodies of the fantastically high densities of white dwarf stars. Let us imagine further that these bodies disturb only the earth's gravitational field of force and not the relative motions of the earth, sun, and moon. Then we can imagine that, under the influence of these dense bodies, the gravity field of the earth would undergo large, violent, and sudden changes. The intensity and direction of gravity would be changed considerably. Gravity might even be reversed for a time. The astronomers watching an eclipse would not be able to maintain their equilibrium, let alone the equilibrium of their eclipse apparatus.

Astronomical latitude and longitude, if they could be observed at all under such conditions, would change abruptly by many degrees, yet all the while the eclipse would go through its normal course, the shadow would fall on a given place at the appointed time, because the calculation was based on geometrical or positional co-ordinates, and not upon directional co-ordinates, that is, co-ordinates given by the earth's field of force.

Instead of the large and varying differences between positional and directional co-ordinates that would be caused by our supposed swarm of heavy bodies, we actually have small and fixed but very real differences caused by the irregular conformation of the earth's physical surface and the irregular distribution of density beneath the surface.

Since the sea-level surface of the earth, that is, the so-called *geoid,* is by definition perpendicular to the plumb line, this sea-level surface is not a smooth mathematical surface like that of an ellipsoid, but an irregular one. We often speak, however, with more picturesqueness than accuracy, of the "humps and hollows of the geoid," for an actual change from convexity to concavity, such as implied by the word "hollow," probably does not exist on the geoid. The curvature of the geoid is, however, extremely irregular in certain places.

The earth surveyor tries to derive positional co-ordinates based on an ellipsoid of rotation that is intended to represent as well as may be the sea-level surface of the earth. But no matter how carefully the earth surveyor chooses the dimensions of this ellipsoid, no matter how carefully he locates and orients it with respect to the points of his survey, he can not make his positional latitude and longitude square with the directional latitude and longitude of the astronomer. These differences between the surveyor's would-be positional latitude and longitude were formerly termed *station errors,* a not very descriptive name. The more modern term is *deflection of the vertical.*

The diagram opposite gives one some idea of how the surveyor works. The arc of triangulation might run east and west, or we might have a whole area covered by triangulation. Some or all of the vertices might be astronomical stations with observed latitudes, longitudes, and perhaps azimuths. Several assumptions must be made: an assumed longitude, latitude, azimuth, of one of the points; an assumed form of the earth or terrestrial ellipsoid (the U. S. Coast and Geodetic Survey uses the Clarke spheroid of 1866); that the triangulation has been reduced to the surface of the assumed ellipsoid. Then, when the positions of the other vertices are *computed* from the data obtained in the triangulation observations, we get discrepancies between the computed values on the ellipsoid and the already observed astronomical values of the latitudes and longitudes of these places. Thus we find the deflection of the vertical at each of these places.

In practice in the past, the surveyor has assumed the deflection to be zero at some initial station, or he has made his assumptions, including assumptions about the size and shape of the

ellipsoid, so that the *average* deflection of the vertical will be reasonably small or as small as possible. At times other factors may make the actual smallness of the deflection a less important consideration.

The actual deflections vary greatly in magnitude—those of five seconds of arc are quite commonplace. Since one second corresponds roughly to 100 feet on the surface of the earth, and five seconds to 500 feet, and since these deflections often change rapidly from place to place, a large-scale map based on astronomical (directional) co-ordinates would often be considerably distorted. In regions such as the Hawaiian Islands, the topography in and around which is such as to cause large and irregular deflections, relative deflections between the two sides of an island may be as much as 60 seconds or one minute of arc.

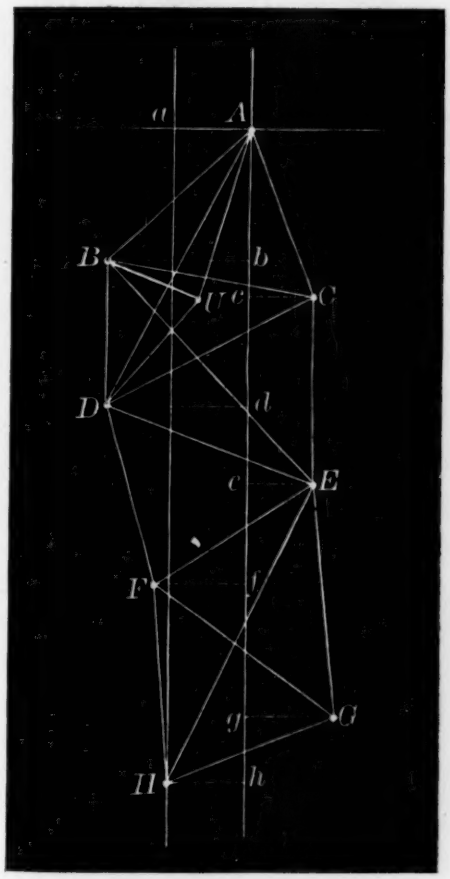
In addition to very large deflections commonly associated with high relief of the earth's surface, mountains and ocean deeps, deflections caused by irregularities of subsurface density occur. The topography around Moscow is not notable for its high relief, but Clarke, in his *Geodesy*, page 288, says:

"A very remarkable instance of such irregularities exists near Moscow, brought to light through the large number of observed latitudes in that district. Drawing a line nearly east and west through the city, this line for a length of 50 or 60 miles is the locus of the points at which the deflection of the direction of gravity northwards is a maximum, amounting nearly to six seconds in the average, while along a parallel 18 miles to the south are found the points of maximum deflection southwards. Midway between these lines are found the points of no deflection."

The earth surveyor of a particular region will probably try to refer his latitudes and longitudes to some ellipsoid best adapted on the whole to that particular part of the earth's surface, one that will minimize the average deflection, as mentioned above. Different surveyors in different regions, however, may use different ellipsoids. Such a region may, of course, be of any size. Small countries, such as Holland and Denmark, have adopted systems of their own, and, conceivably, even smaller regions might be considered. At the other end of the scale of the size of these various regions are the United States, Canada, and Mexico, all on one system, India, and, perhaps, the U.S.S.R., about which information is lacking.

Furthermore, even though two separate regions may be referred to ellipsoids of the same size and shape, there is no guarantee that the two are identical in position with respect to the center of gravity of the earth and in orientation with respect to the earth's axis. In other words, the deflections with which the earth surveyor deals are for the present necessarily based on arbitrary assumptions.

Just when totality begins and ends, the bright-line flash spectrum may be taken with a slitless spectrograph. At the 1936 eclipse, the green light of the corona produced the large ring.



In this triangulation, each station is visible from at least two others. When the base line, BU, and all angles are accurately measured, all distances can be calculated with exactness, including the north-south line, aH, of the terminal stations. From "Astronomy," by Russell, Dugan and Stewart.

What the earth surveyor would like to have but does not now have is a system of deflections by which all parts of the globe are referred to the same ellipsoid, centered at the earth's center of gravity and with its axis of rotation coincident with the earth's axis. Perhaps in the not-too-distant future we will have such a system derived from values of the acceleration of gravity (the vertical instead of the horizontal component of the earth's field), but that is a highly technical subject and aside from our present consideration.

Returning to the eclipse, the latitude and longitude that appear in the formulas for computing the times of contact of an eclipse at a given place are really positional or geodetic latitude and longitude, *but the latitude and longitude that are commonly used in these formulas* for the purposes of prediction are from necessity astronomical or directional, since they are usually the only ones available. These latter should, therefore, be corrected (but by unknown amounts) so as to reduce them to our ideal system of positional co-ordinates. Suppose that in setting up the equations of the times of an eclipse we introduce these unknown corrections to the astronomical co-ordinates. Then the actual timing of the phases of an eclipse give us conditions for determining these corrections.

The times of the eclipse are predicted for a geographical position, whereas the eclipse astronomer observes his astronomical position. The times of contact that he observes are not identical with the predicted times because the prediction is really for a somewhat different locality. However, errors in the tables of the positions of the moon, sun, and stars, also affect the predicted times of contact. These tabular errors vary with time, and are therefore particularly trouble-

some, but the undetermined deflections of the vertical are practically constant.

The eclipse of July 9th could thus serve to tie together geometrically two regions of the earth far removed from each other, say, Canada and Russia. These two regions have been surveyed on different "systems of deflection" and with the results of the surveys referred to different ellipsoids. The eclipse would help tie together such regions without reference to the earth's gravitational field. A part of the difference in predicted and observed times enables us to reduce the astronomical position of the observer to the ideal system of geographical coordinates. The computation of the distance between any two points is then a matter merely of the geometry of the ellipsoid. This is the equivalent of Bonsdorff's proposal to determine the distance between two points on the earth by timing the phases of an eclipse.

Presumably, the tabular errors mentioned above would at least be practically constant for the same eclipse or occultation. One advantage in observing an eclipse rather than an occultation is the possibility of very accurate timing (proposed by Lindblad) by means of the instantaneous appearance and disappearance of the flash spectrum at the moments of the beginning and ending of totality. Occultations, however, have the advantage over eclipses that they occur much more frequently.

During a solar eclipse, as long as any of the sun's photosphere is visible, the spectrum along the moon's edge appears as the normal, dark-line, solar spectrum. This abruptly changes to a bright-line spectrum when the photosphere is obscured, for then the light is coming only from the relatively rarefied gases of the sun's atmosphere. Inasmuch as the inner corona may appear before totality begins, and Baily's beads are a difficult phenomenon to time, the photographic observation of the flash spectrum's appearance should give precise values for the instants of second and third contact.

Eclipses and occultations, then, may be used to determine deflections of the vertical. But perhaps the earth surveyor has something to contribute to the astronomer who is trying to follow the motions of the moon and who uses occultations to correct his lunar tables. As mentioned above, both the deflection and the tabular errors combine to produce discrepancies in the times of phases of eclipses and occultations. Perhaps the astronomer might accept from the earth surveyor such deflections as the latter can provide, admittedly imperfect though they now are, in order to get from the occultations a better set of corrections to the moon's tabular places.

ASTRONOMICAL ANECDOTES

FERGUSON ON ECLIPSES

LAST MONTH in this column reference was made to James Ferguson, whose little book *Astronomy* may have been the thing that turned William Herschel's mind to the pursuit of the science. Here and there in very good and complete libraries can be found another of his several books, one that is of more than ordinary interest this month. The title page is like this:

ASTRONOMICAL TABLES
AND
PRECEPTS
For calculating the true Times of
NEW and FULL MOONS,
and shewing the method of projecting
ECLIPSES,
from the
CREATION of the WORLD to A. D. 7800
To which is prefixed
A Short THEORY
of the
SOLAR and LUNAR Motions.
By JAMES FERGUSON
LONDON
Printed for the Author, MDCCLXIII.

Now that's a pretty tall order—from the creation of the world to 7800 A.D.—and one that demands some precise constants; extrapolation over only a few centuries is likely to mess up an eclipse prediction.

The theory of the motions occupies 12 pages; there is nothing very abstruse there, for there was no attempt made to explain any of the inequalities and irregularities; a statement is made and is to be accepted as a fact of observation, divorced from gravitational theory.

Then come 18 pages of tables, the last five having to do only with eclipses. The tables are fairly easy to use, although sometimes the interpolation is a little difficult. Then there are 10 pages of examples, illustrating how to calculate the true time of new or full moon. Following this, 14 pages are devoted to solar eclipses and the method of projecting them geometrically on the earth, and eight pages deal with lunar eclipses.

Here, in little more than 60 small pages, is enough material to keep a really alert amateur busy for many long winter hours, playing at mathematical astronomy made easy. The difficulty arises from the fact that the book is all but unobtainable. I could be persuaded to furnish photographic reproductions at cost, but wait until you've read what follows here, before asking.

In approximately 12 minutes, I calculated from the tables the time of true new moon in July, 1945. The result was July $9^d\ 13^h\ 39^m\ 50^s$ U.T. But the *American Ephemeris and Nautical Almanac* gives the time as $13^h\ 25^m\ 09^s$; the error, therefore, is $14^m\ 41^s$, not so bad for an ordinary new moon, but not so good for this one, that brings an eclipse of the sun.

The obvious sources of the errors in Ferguson's tables are the values of the various periods used. I recalculated several of his tables, using modern data. The values used by Ferguson and by me are given below:

Year			*Ferguson*		*Modern*	
	day	hr.	min.	sec.	min.	sec.
Tropical	365	05	48	55	48	45.975
Sidereal	365	06	09	24	09	09.540
Anomalistic	365	06	14	00	13	53.011
Month			*Ferguson*		*Modern*	
	day	hr.	min.	sec.	min.	sec.
Sidereal	27	07	43	04	43	11.510
Anomalistic	27	13	18	43	18	33.163
Synodic	29	12	44	03	44	02.820
Nodical	27	05	04	37	05	35.808

Using the new tables, and others of Ferguson's uncorrected, the time of true new moon in the example became July $9^d\ 13^h\ 27^m\ 01^s$, with an error of $1^m\ 52^s$. This residual error can easily arise from accumulated errors in the tables left uncorrected, and in failure to take into consideration the secular changes in the periods tabulated above. Lacking the time, I have not calculated the circumstances of the eclipse. As an incidental result, however, the sun's distance from the node of the moon's orbit is found to be 8° 52′, well within the ecliptic limits, so we can be sure that, according to Ferguson, an eclipse will occur July 9, 1945.

The examples used by Ferguson are of more than passing interest. One of them is the calculation of "the true time of new moon in May, old style, the year before Christ 585." The result is 585 B.C., May 28th, "at 2 minutes 30 seconds past IV in the afternoon." This is the famous eclipse predicted by Thales; even in Ferguson's day this eclipse prediction and the exact date of it were recognized to be of importance.

Another example is the true time of full moon in April, 30 A.D. The result is April $6^d\ 20^h\ 25^m$ U.T. This was the full moon that marked the beginning of Passover — a certain Thursday evening when a Teacher and his 12 disciples sat down to what we know as the Last Supper. R.K.M.

NEWS NOTES

By Dorrit Hoffleit

NORMAL COMMUNICATION RESTORED

Just as Harvard is the clearinghouse for astronomical information on this continent, particularly that of "spot-news" character, requiring redistribution by telegraph, so the observatory at Copenhagen is clearinghouse for the Eastern Hemisphere. During the war, however, this function was taken over as much as possible by Swedish astronomers at Lund, and delays in our communication with Copenhagen and astronomers on the continent were inevitable.

Astronomical news on comets, novae, and other elusive objects must be transmitted by telegraph to astronomers the world over if such objects are to be adequately observed before they move too far or become too faint. It is good news to the astronomical world, therefore, that Professor Elis Stroemgren, of Copenhagen Observatory, has telegraphed Harvard College Observatory directly:

"Please from now on send again astronomical mail and telegrams directly to Copenhagen."

EXCHANGE OF MASS

The first *Circulaire* since the disruption of communications that we have received directly from the *Bureau Central des Telegrammes Astronomiques* (these circulars are the European counterpart of Harvard Announcement Cards) deals with Beta Lyrae, one of the most famous of binary stars. Professor Paul Guthnick, of Berlin-Babelsberg Observatory, obtained in 1943-44 photoelectric measurements of the pair's magnitude. These he correlated with measurements made elsewhere in the past by Stebbins, Huffer, and Smart.

The conclusion was reached that a transfer of mass between the two components of this double star accounts for marked slow changes in brightness not explained by normal eclipse phenomena. The components of Beta Lyrae are known to be in contact (see *Sky and Telescope*, March, 1942, page 4), and in 1916-25 the net flow of matter was from the smaller to the larger component; this also held true in 1934-43, but in 1926-33 the flow was reversed. This transfer of material induces a change in the relative radii of the components, their ratio varying from 0.681 to 0.815 (largest in 1915-16.)

"Should the phenomenon turn out to be periodic, a period of 18 years would have to be considered," explained Professor Guthnick. He finds his results to correlate well with conclusions previously reached by O. Struve and G. P. Kuiper, of Yerkes Observatory, from spectroscopic and theoretical analyses.

DOES THE EARTH HAVE A TAIL?

Like comets, the earth may have a gaseous tail, Dr. I. S. Astapowitch proposes in one of the recent *Astronomical Circulars*, U.S.S.R., where he describes his visual observations of the counterglow, more commonly known as the gegenschein. The observed wave lengths suggest that this hazy patch of light (seen at the place in the zodiac opposite the sun) may be part of the earth's atmosphere, the light probably originating from oxygen and nitrogen.

Measurements of the parallax of the gegenschein, difficult to make, indicate distances of from 150,000 to 200,000 kilometers. This may be the length of a cometary tail of the earth's atmosphere extending about 50 earth diameters, or well beyond the orbit of the moon. Particles of this tail would be moving in hyperbolic orbits convex toward the sun, because of the pressure of sunlight. The Russian astronomer briefly gives reasons why Jupiter should not be expected to show such a tail and why Venus might have one.

ASTRONOMER IN RUSSIA

Among the American scientists now in Moscow to attend the celebration of the 220th anniversary of the founding of the Academy of Sciences of the U.S.S.R. is an astronomer, Dr. Harlow Shapley, director of Harvard College Observatory. He and nearly a score of scientists and members of scientific and cultural organizations left New York early in June on a Soviet plane, flying by way of Alaska and Siberia to arrive in time for ceremonies in Moscow and Leningrad extending from June 15th to 28th.

At the time of official announcement of the international voyage, 14 men had accepted the invitation of the Soviet government. They are Dr. James W. Alexander, professor of mathematics at the Institute for Advanced Study, Princeton University; Dr. Detlev W. Bronk, professor of biophysics at the University of Pennsylvania; Dr. James E. Church, of Reno, Nev., meteorologist and snow authority for the U. S. Weather Bureau; Dr. Edward U. Condon, associate director of the Westinghouse research laboratory at East Pittsburgh, Pa.; Dr. Henry Field, of the Library of Congress; Dr. Isaac M. Kolthoff, head of the chemistry department of the University of Minnesota; Dr. Irving Langmuir, associate director of the General Electric research laboratory at Schenectady, N. Y.; Dr. Duncan A. MacInnes, member of the Rockefeller Institute for Medical Research; Dr. James W. McBain, professor of chemistry at Stanford University; Dr. Arpad L. Nadai, consulting engineer of the Westinghouse laboratory; Arthur Upham Pope, archeologist and director of the Iranian Institute, New York City; Dr. Shapley; Edwin S. Smith, director of the National Council of American-Soviet Friendship, Inc.; Dr. Manuel S. Vallarta, president of the Mexican Academy of Sciences.

In addition, a scroll of greetings to the scientists of the Soviet Union signed by 12 other American scientists was turned over to Dr. Shapley by Dr. Harold C. Urey, Columbia University. Dr. Albert Einstein was among the signers of this scroll. The National Academy of Sciences is represented by Dr. Bronk; the Society of Sigma Xi by Dr. Shapley. He is also taking with him photostatic copies of correspondence and minutes of meetings exchanged between Benjamin Franklin, one of the original members of the American Philosophical Society, founded in 1727, and the Russian Academy of Sciences, which was founded two years earlier.

Astronomical photographs and information of use to 20 Russian eclipse expeditions is also being carried by the Harvard astronomer. It is expected that this will indicate the ever-growing desire of American astronomers to co-operate with their energetic Russian contemporaries. All fields of science should be benefited by the present exchange of ideas during the Russian scientific celebration.

CORRECTION

We wish to thank A. W. Mount, of Ft. Worth, Tex., for calling attention to an incorrect impression conveyed in our report entitled "Ice on the Moon?" in the April issue, page 9. Our first paragraph erroneously implied that the northern rim of Plato itself appeared razed to the surrounding level, whereas in Mr. Wilkins' paper the rim to which he actually referred is that of a small craterlet that stands near the center of Plato. This makes quite a difference, as Plato itself is one of the largest walled plains on the moon.

STARS OF

By Marian Lock[illegible]od

Giants and deadly animals furnish the [illegible]n
There is much of interest in their story, [illegible]ld
Planetarium this [illegible]h.

The Dragon and the Dippers are conspicuous summer star groups.

Ye quenchless stars! so eloquently bright,
Untroubled sentries of the shadowy night.

—Robert Montgomery

FORTUNATE and happy is the man whose interests lead him to a study of the heavens above him. In the pursuit of the stars he will find surcease from the troubles and trivialities which plague his earthly round of days and nights. Within him will be stirred the deepest depths of awe and wonder as he learns to realize more fully the mystery and boundless spaces of the universe. Flowers, birds, insects, rocks—all a part of the universe, all subtly rewarding to the student, but over and above them, beyond them forever, the stars!

What are the names of the stars that scintillate so far away? What has man been thinking of them through the thousands of years he has lived upon this planet? Do you know the giants who stand stretching across the limitless blue reaches of the sky? What legends of giants have lighted fires in man's mind through the ages, that he has placed these colossi there, head to head, covering the summer sky, standing each with his feet upon a dread animal?

In the twilight which falls over the earth about nine o'clock on the first of July, the Big Dipper has already begun to slide down the western slope of the heavens from its highest point above the pole. Cassiopeia, the famous W, is just as slowly climbing up the eastern sky from the northern horizon, both groups of stars circling around Polaris with a counterclockwise motion. Polaris, the 2nd-magnitude star which is now less than one degree from the north celestial pole, can be located, as always, by the two pointer stars at the end of the Dipper's bowl. By extending this line as far again to the other side of Polaris, one may find Cassiopeia, which is within the Milky Way. Polaris marks the end of the Little Dipper's handle. Imagine that the Little Dipper is swinging around the pole, tacked to the sky by the end of its handle, Polaris, and trace it in an arc from Polaris toward Mizar, which marks the curve in the handle of the Big Dipper.

Circling between the two dippers is the age-old figure of Draco, the Dragon, believed by some of the early commentators to represent the serpent which so successfully tempted Eve in the Garden of Eden. The tip of the Dragon's tail is marked by the star Lambda Draconis, otherwise known as Giansar (meaning, according to some authorities, the "Central One" because of its position almost between Polaris and the Pointers in the bowl of the Big Dipper). By following the tail of the dragon eastward from its tip one is led through a course of stars which half encircle the Little Dipper and then curve south and west. The Dragon's head is a group of stars shaped more or less like a keystone, the brightest star of which can be found some 12 degrees from Vega, a bright blue star high in the eastern sky at this time. The brightest star in the Dragon's head is called Etamin (sometimes Eltanin) and marks one of Draco's eyes. It is of particular interest because it played a prominent part in the discovery of the aberration of light by Bradley in 1727. Etamin lies almost exactly in the zenith of Greenwich, and for that reason has been known as the "zenith star."

While Draco is a constellation composed mainly of 3rd- and 4th-magnitude stars, there are few groups more interesting historically. The star Thuban (Alpha Draconis), which lies between Mizar and Kochab, was the pole star in 3500 B.C., and it was possibly to the north as marked by this star that the Great Pyramid of Giza was oriented. Some authorities believe that Thuban must have shone originally with much greater brilliance than it does at the present time. This star crosses the meridian on July 7th at 8:00 p.m. E.W.T., which means that by dark it will be found somewhat west of the meridian. Within Draco is located the north ecliptic pole, at declination +66½°, and right ascension 18 hours. For the amateur observer, Draco is a good hunting ground containing many easy double stars which can be separated with low-power instruments.

Any stargazer, no matter how inexperienced, can find without difficulty the great and beautiful constellation of Scorpius, whose tail just skirts the southern horizon as seen from the latitude of New York City. In this constellation, the outstanding one of the summer heavens, shines the bright star Antares, one of the largest stars known, and red in color. The outline of the Scorpion resembles that of a baling hook.

Above the Scorpion is a rather vaguely outlined figure of stars known as Ophiuchus, the Serpent Bearer. In mythology, Ophiuchus has been frequently identified with Aesculapius, the inventor and god of medicine. The legend explaining the elevation of Ophiuchus to the heavens is an interesting one. Pluto, the god of the underworld and hence of the dead, feared the skill of Ophiuchus, for it was said that this great physician could raise even the dead with his ministrations. Pluto, for this reason, and because he did not wish the underworld to be depopulated, used his

Ophiuchus and Serpens and some neighboring stars.

SUMMER

LOCKWOOD

he ...on in warm summer skies.
ry, ...old here and in the Hayden
his ...th.

A telescopic view of the great globular cluster in Hercules.

influence to have Ophiuchus removed from the earth and placed in the sky where he could do no more damage to Pluto's realm. This constellation has been by others believed to represent the well-known classic figure of Laocoön, the Trojan priest of Apollo, who with his two sons was crushed to death in the coils of enormous serpents. Below Corona Borealis a faint X marks the head of Serpens, the serpent which Ophiuchus carries.

In Ophiuchus there are many rich sections of the Milky Way, and, particularly, dark areas or dark nebulae which make striking photographs. Here there appeared in 1604 the famous nova known as Kepler's star, which became even more brilliant than Venus at its brightest. Within the confines of Ophiuchus, several other brilliant novae have appeared through the ages.

Near Cheleb, which is Beta Ophiuchi, there is a beautiful group of stars of the 8th magnitude visible in good binoculars. Just east of Cheleb is the small V-shaped group of stars known as the Bull of Poniatowski, and sometimes likened in miniature to the larger V-shaped head of Taurus, the Bull. This asterism was named after a king of Poland.

It was in 1916 that E. E. Barnard, one of the greatest of astronomical observers, discovered in Ophiuchus a 9th-magnitude star, since called Barnard's star, which has the largest known proper motion. It moves across the sky at the rate of 10 seconds of arc a year, and is also sometimes called "the runaway star."

In 1934, the nova in Hercules attained the 1st magnitude.

A little more than half the way on a line from Antares to Vega, Alpha Ophiuchi, otherwise known as Rasalhague, can be located. Rasalhague forms an isosceles triangle (almost equilateral) with Altair and Vega, Altair at the apex.

Rasalhague, marking the head of Ophiuchus, is removed by only five degrees from the star Rasalgethi in the head of the other giant. Hercules kneels solidly upon the body of the Dragon, while Ophiuchus stands with his feet upon the Scorpion. The constellation figure of Hercules is somewhat involved and hard to trace, but the great letter H of Hercules can be found just to the east of the Northern Crown. The eastern side of the H is much more curved than the western side. A line drawn from Alphecca, the brightest star in the Northern Crown, to Vega will cross diagonally through the upper half of the H.

On a line between the stars Zeta and Eta in Hercules is a spot of light just visible to the naked eye. Here, as always with faint objects, visibility will be better if the observer will look a bit to one side and not directly at the patch of light, since the periphery of the eye is more sensitive. This faint spot is the great globular star cluster, M13, one of the most spectacular and interesting of all celestial objects. This enormous ball of suns is about 31,000 light-years from us, and contains tens of thousands of stars, perhaps as many as 100,000.

It is in the general direction of Hercules that the sun and its traveling companions seem to be heading.

Early in the month of July, and just after dark, a bright star will be seen halfway up from the southern horizon, to the south and a little to the west of Arcturus. This star is Spica, easily found by extending the curve of the Big Dipper's handle twice its length to Arcturus, and then on about as far again. To the west of Spica is the four-sided group known as Corvus, the Crow. but looking like a sail. The top stars of the sail form an infallible guide to Spica. Spica is the brightest star in Virgo, who was identified by the poet Aratos with Astraea, the goddess of Justice. Aratos writes of the formation of this constellation as follows: "Justice was shocked—the blood-stained earth she flies—Jove bade her welcome to her native skies."

In Virgo, the celestial equator, the ecliptic, and the equinoctial colure intersect, just to the east of Eta Virginis. The point of intersection is known as the autumnal equinox and marks the sun's crossing of the celestial equator to the south. The star Epsilon Virginis was known as "the Grape Gatherer," rising just before the sun at the time when the grapes were ripe.

The amateur observer will be interested to trace out the famous "Diamond of Virgo," formed by Spica, Arcturus, Cor Caroli, and Denebola. Cor Caroli is the brightest star in the constellation Canes Venatici, directly under the handle of the Big Dipper.

NOTE: In an article of this length it is impossible to cover in detail all the summer constellations. It is suggested that this material be used in conjunction with the article on "Summer Stars" in the July, 1944, issue of *Sky and Telescope*. In this way a more complete picture of the sky can be obtained.

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HANDBOOK OF METEOROLOGY

Edited by F. A. BERRY, JR., Comdr., USN, Staff Comair 7th Fleet; E. BOLLAY, Lieut. Comdr., USNR, Aerological Staff, Postgraduate School, U. S. Naval Academy; and N. R. BEERS, Lieut., USNR, Postgraduate School, U. S. Naval Academy. In press—ready in August.

The most complete work of its kind ever published, this handbook constitutes an invaluable text and reference book covering the entire subject of meteorology, and presenting a wealth of authoritative information needed by both the beginner and the expert in the field.

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BOOKS AND THE SKY

THE COMET OF 1577
Its Place in the History of Astronomy

C. Doris Hellman, Columbia University Press, New York, 1944. 488 pages. $6.00.

THE writer of this review finds the world on V-E day more rocket-minded than comet-minded, but in happier times men will turn again to the orbit studies of Brahe, Kepler, Newton, and Gauss.

A new chapter in the history of astronomy began when Tycho Brahe found that the comet of 1577 had about the same position among the fixed stars when seen from Praha as from his observatory on the Danish island of Hveen in the Baltic Sea. He concluded, therefore, that the comet was "supralunar" or more distant than the moon. Some of Tycho's scientific contemporaries obtained similar results; others, who did not, thought that the comet was closer than the moon. At the time, the moon's distance was known only approximately, and almost two centuries were to elapse before a fairly reliable measure of the distance to the sun was made (1769), and over 250 years before a true stellar parallax could be obtained.

Tycho, working, of course, before the invention of the telescope, found on the basis of his measurements that the comet was about four times as remote as the moon. His observations, the best made on the comet, were precise enough for an orbit to be deduced from them in the 19th century.

The scope of the book is broader than its title would indicate. The first two chapters trace the development of cometary theories from antiquity to 1577—a long record of awe and superstition. Comets were variously considered as harbingers of wars, deaths, and ills, or as causing winds and droughts.

Tycho's observations of the comet of 1577 marked not only a milestone in the advance of scientific astronomy, but they are also to be thought of as important in helping to delineate the boundary between astronomical and meteorological phenomena. For 18 centuries since Aristotle had written his **Meteorologica,** men had generally believed comets to be atmospheric condensations. Tycho placed comets at a great distance from the earth, and thus far beyond the earth's sensible atmosphere.

Fourteen years of research have produced a monograph which will be of interest alike to students of the growth of astronomical and meteorological thought and to students of Elizabethan literature. The work exhibits the cosmopolitan character of 16th-century astronomy as the author ranges through Greek, Latin, Arabic, French, German, Dutch, Italian, and Czech titles in her copious bibliography.

RALPH S. BATES

WHAT ARE COSMIC RAYS?

Pierre Auger. Translated from the French by Maurice M. Shapiro. University of Chicago Press, Chicago, 1945. 128 pages and plates. $2.00.

THE subject of cosmic rays has been expanding with great rapidity during the past decade. The active research men have been doing and not talking; as a result there have been very few books on the subject written by competent persons. Almost all of the latest developments in this field are described only in the technical literature. Consequently, it is with pleasure that we welcome this book by Pierre Auger. Dr. Auger is well versed in the subject, having contributed notably to the advancement of knowledge of cosmic rays. He has conducted extensive investigations on the higher-energy component of cosmic rays. Dr. Shapiro, his translator, is also thoroughly familiar with

Some Harvard Observatory Publications

The Universe of Stars — 1929 edition of a series of radio talks by Harvard astronomers; in four parts on the Material of Astronomy, the Solar System, Stars and Nebulae, the Stellar Universe. 198 pages, including an index; illustrated ——— $1.25

The History and Work of the Harvard Observatory — 1839 to 1927. By Solon I. Bailey. An outline of the origin, development, and researches of the Astronomical Observatory of Harvard College, together with brief biographies of its leading members. 301 pages, including subject index and name index. Published in 1931 ——— $2.50

Tercentenary Papers of the Harvard Observatory — Vol. 105 of Harvard Annals, 1937. Thirty-four papers on current astronomical researches at Harvard. Astrophysics, meteoric astronomy, photometry, and the problems of stellar distribution, variable stars, and external galaxies are about equally represented. Numerous plates, tables, diagrams, and subject bibliographies. 632 pages ——— $4.00

History and Bibliography of the Light Variations of Variable Stars; supplementary volume containing the stars recognized to be variable during the years 1931-1938. By Richard Prager. This Vol. 111 of Harvard Annals, 1941, supplements the earlier variable-star surveys with which the author was long associated at the Berlin-Babelsberg Observatory. 251 pages ——— $4.00

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By EARLE B. BROWN

Foreword by James G. Baker of Harvard Observatory

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The first of four parts covers completely the principles of geometrical optics; then there is a discussion of the operation and theory of optical instruments. The third part covers the construction and maintenance of both optical and mechanical parts of instruments of all kinds. In the fourth part such supplementary topics as the manufacture of optical glass, mathematical proofs, and a glossary of terms, are included. There is an adequate index.

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the entire field and has himself done significant work.

The book starts with the initial discovery of residual ionization leading to the recognition that cosmic rays existed. From there the development is rapidly traced through the picturesque phase of the worldwide survey expeditions, to the present stage of research in which most of the work is done by rather complex arrangements of Geiger counters and cloud chambers and is sometimes aided by high-altitude balloon or airplane flights. Dr. Auger describes the experiments leading to the recognition of the positive electron and the positive and the negative mesotron. These three new particles were brought to light through cosmic ray investigation. In short, Dr. Auger describes the modern picture of cosmic rays.

In the preface the translator says: "This book is written primarily for the reader who lacks a technical knowledge of physics but who wants to keep in touch with current developments in science. It is not intended for the specialist but should provide a good perspective for the physicist who wants to get a quick view of what has been done in this new field." It would be more accurate to say that the book is primarily of value to the reader who is already familiar with some allied branch of science. It is written on the semi-technical level, which should be particularly suitable to persons who are acquainted with scientific terminology, but whose primary interest is in some other field in the physical sciences. For example, an amateur astronomer will understand most of the concepts assumed by Dr. Auger and will at the same time derive much useful information from the book.

The binding is of good quality, the type is easy to read, and the photographs at the end illustrate the main cosmic ray phenomena and are both interesting and instructive.

SERGE A. KORFF
New York University

NEW BOOKS RECEIVED

ELECTRONICS: TODAY AND TOMORROW, *John Mills*, 1944, *Van Nostrand*. 178 pages. $2.25.

A book for the layman, in two parts, discussing electron tubes and electronic devices, and answering many questions which the intelligent person interested in current and future science asks.

COASTS, WAVES, AND WEATHER FOR NAVIGATORS, *John Q. Stewart*, 1945, *Ginn*. 348 pages. $3.75.

One of the co-authors of *Marine and Air Navigation* has written a companion volume to that text. The new book is in three parts: coast lines, terrain, and routes; oceanography; and meteorology.

THE COMING AGE OF ROCKET POWER, *G. Edward Pendray*, 1945, *Harper*. 244 pages. $3.50.

Something of the past and the present state of development of the science of rocketry and jet propulsion, by an expert in the field. The author discusses various of the engineering problems involved, and also investigates future possibilities of rocket use and rocket transportation.

Amerigo Vespucci
PILOT MAJOR
By Frederic J. Pohl

"The student of geography, astro-navigation, and exploration will experience many interesting moments." — *Sky and Telescope.*

"Mr. Pohl has written his learned and extremely interesting biography in a spirit of warm-hearted championship." —*New York Times.* $3.00

The Comet of 1557
By C. Doris Hellman

"This book should be of importance to persons interested in the period and subject." — *U. S. Quarterly Booklist.*

"Dr. Hellman's work is for specialists, for whom she has prepared an accurate and exhaustive bibliographical study on the theory of comets up to 1577 and the literature inspired by the comet of that year."— *The Sign.* $6.00

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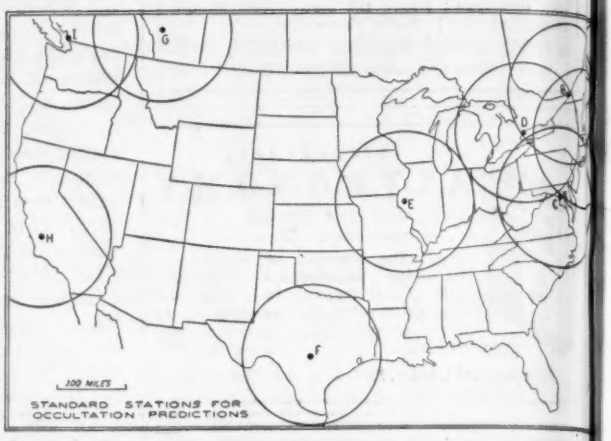
OBSERVER'S PAGE

By Jesse A. Fitzpatrick

All times mentioned on the Observer's Page are Eastern war time.

Your Local Station and Occultation Predictions



OCCULTATIONS are among the most interesting of celestial phenomena for the amateur observer equipped with a moderate-sized telescope, whether he observes just for the fun of watching the moon blot out a star or wishes to make well-timed observations of value to professional astronomers keeping tabs on the moon.

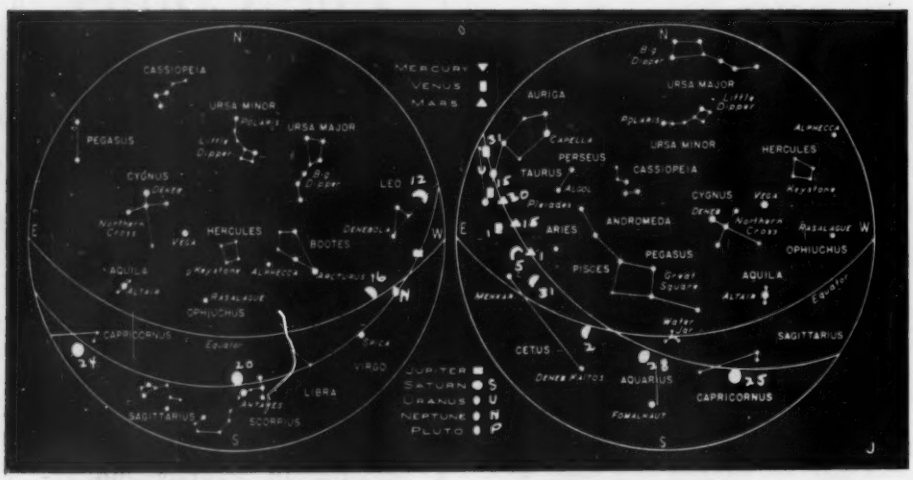
But the moment of immersion for a particular star is a widely varying quantity, depending on the observer's latitude and longitude and on many other factors involved in the occultation itself. Probably the lack of easily obtained predictions for one's local observing station tends to keep amateurs from making occultation observations as frequently as they watch the phenomena of Jupiter's satellites or the minima of Algol. Yet occultations may often fill in one's observing time, particularly when the moon is bright and perhaps making observation of clusters, nebulae, and the like, difficult. Perhaps the arrangement of predictions published here will help observers in parts of the country not close to the standard stations to know about when to expect an occultation, and those near more than one standard station may take an "average" of the computation by **a** and **b** quantities for several stations.

For a particular station, the differences in longitude and latitude from any one standard station are always the same, so the **a** and **b** computation is really very simple. An observer far from any standard station can nevertheless estimate approximately when to expect favorable occultations, especially if an occultation is predicted for stations both to the east and west of him.

We have selected these occultations on the basis of their general visibility in all or part of the country. Many of them are visible at the four Canadian stations (**B**, Montreal; **D**, Toronto; **G**, Calgary; **I**, Vancouver) even though no times are predicted in the British **Nautical Almanac**, where these stations are listed. When such information is given, it conveniently supplements the data for United States' stations, and is included here.

Those who have trouble using the **a** and **b** quantities should consult the **American Ephemeris** or write us a note explaining their difficulty. We shall be glad to have further comments and suggestions on this plan of presenting occultation predictions. Those wishing to predict other occultations or who live far from standard stations may wish to employ a handy graphical method described in **Sky and Telescope**, June, 1942, page 14; five or six minutes is the greatest error to be expected by this method, which requires the use of trigonometry, logarithms, and data given in the **American Ephemeris**.

The Moon and Planets in the Evening and Morning Skies



In mid-northern latitudes, the sky appears as at the right at 4:30 a.m. on the 7th of the month, and at 3:30 a.m. on the 23rd. At the left is the sky for 10:30 p.m. on the 7th and for 9:30 p.m. on the 23rd. The moon's position is given for certain dates by symbols which show roughly its phase. Each planet has a special symbol, and is located for the middle of the month, unless otherwise marked. The sun is not shown, although at times it may be above the indicated horizon. Only the brightest stars are included, and the more conspicuous constellations.

Mercury attains greatest eastern elongation on the 23rd, when it is 27° from the sun and its magnitude is +0.6. Throughout the month the planet sets an hour, more or less, later than the sun, so there is opportunity for all to see it.

Venus is in Taurus, rising three hours ahead of the sun at the end of the month.

Earth is at aphelion on July 5th, 94,452,000 miles from the sun.

Mars is rising in the very early hours, just after midnight at the end of the month, when it is situated between the Hyades and the Pleiades.

Jupiter must be observed early in the evening, in Leo.

Saturn is passed by the sun on the 6th, and may be seen just before sunrise near the end of the month, in Taurus.

Uranus is in Taurus, in conjunction with Venus on July 22nd.

Neptune is in Virgo.

COMET KOPFF RETURNS

ONLY two days after he had found one periodic comet, Pons-Winnecke, which was running right on schedule, Henry Giclas, astronomer at Lowell Observatory, duplicated his discovery for Comet Kopff, which was also on time. Dr. V. M. Slipher, director at Lowell, telegraphed Harvard on May 12th (too late to be reported in our June issue), that Mr. Giclas had observed the second comet on May 7th at right ascension $15^h\ 0^m.2$, declination —24° 27'.4. This is in Libra.

The motion of the comet was bringing it northward and westward, into favorable position for observation, but with rather large telescopes as it was of the 13th magnitude, nearly as faint as Pons-Winnecke. On May 15th, Comet Kopff was at $14^h\ 55^m.5$, —23° 17'.7,

PHASES OF THE MOON

Last quarter	July 2,	2:13 p.m.
New moon	July 9,	9:35 a.m.
First quarter	July 17,	3:01 a.m.
Full moon	July 24,	10:25 p.m.
Last quarter	July 31,	6:30 p.m.

according to an observation by B. P. Sharpless with the 40-inch reflector of the U. S. Naval Observatory. On May 12th, Dr. G. Van Biesbroeck, observing at McDonald Observatory in Texas, found Comet Kopff of the 12th magnitude with a faint tail 1′ long extending from a coma 10″ in diameter.

Coincidences abound in this re-discovery by the same astronomer of these two periodic comets. They both take slightly more than six years to go around the sun, being members of Jupiter's family of comets. On its latest circuit each comet passed very close to Jupiter, and was considerably perturbed by the massive planet's gravitation. They pass not far from each other as we see them in the sky; Pons-Winnecke reaches perihelion on July 8th, and Comet Kopff a similar position in its orbit about a month later.

As mentioned in the announcement of the return of Pons-Winnecke, copies of predicted positions for both of these comets are available for those having large telescopes, upon request to the editor of **Sky and Telescope.**

OCCULTATION PREDICTIONS FOR JULY

4-5 *3 B Tauri* 6.4, 3:08.3 +12-50.4, 25, +74° —6° Em: *A* 9:00.1 —3.1 —2.4 322°; *C* 8:54.6 —2.1 —1.3 317°; *F* 8:38.7 —0.6 —1.5 318°.

16-17 *80 Virginis* 5.8, 13:32.7 —5-07.0, 8, +85° +18° Im: *F* 5:42.0 —0.4 —2.4 145°; *G* 4:47.4 —0.9 —1.9 116°; *H* 5:12.0 —1.0 —2.4 140°.

20-21 *123 B Scorpii* 6.5, 16:37.3 —20-18.2, 11, +70° +8° Im: *A* 3:27.3 —1.8 —0.7 80°; *B* 3:23.4 —1.7 —0.6 75°; *C* 3:20.7 —2.1 —0.6 87°; *D* 3:13.5 —2.0 —0.4 80°; *E* 2:48.7 —2.3 —0.1 94°; *F* 2:36.9 —2.1 —0.8 123°; *H* 2:02.5 —0.6 —0.7 143°.

22-23 *24 Sagittarii* 5.7, 18:30.5 —24-4.5, 14, +66° +28° Im: *A* 6:12.6 —2.3 —3.1 146°; *C* 6:13.4 —2.8 —3.9 151°; *E* 5:36.9 —2.2 —1.6 133°; *F* 5:47.5 ... ... 168°; *H* 4:49.7 —0.7 —2.1 158°.

26-27 *56 Aquarii* 6.4, 22:27.3 —14-52.1, 18, +72° —5° Em: *A* 10:34.9 —0.6 —0.3 237°; *C* 10:32.4 —0.7 0.0 232°; *E* 10:17.4 —1.5 —0.4 255°; *F* 10:06.1 —1.7 +0.5 241°; *H* 9:13.0 —2.9 —0.6 295°.

27-28 *336 B Aquarii* 6.5, 23:26.2 —9-34.1, 19, +75° —7° Em: *E* 12:31.9 —0.6 +0.3 224°; *F* 12:18.2 —0.4 +1.8 199°; *H* 11:55.7 —2.0 +0.1 256°.

28-29 *24 B Ceti* 6.0, 0:07.5 —5-33.2, 20, +85° +1° Em: *A* 5:15.8 —1.4 +0.8 288°; *B* 5:16.6 —1.4 +0.8 295°; *C* 5:06.8 —1.2 +0.9 284°; *D* 5:08.2 —1.1 +0.8 296°; *E* 4:56.2 —0.5 +0.8 292°.

For selected occultations (visible at three or more stations in the U. S. and Canada under fairly favorable conditions), these predictions give: evening-morning date, star name, magnitude, right ascension in hours and minutes and declination in degrees and minutes, moon's age in days, limiting parallels of latitude, immersion or emersion; standard station designation, G.C.T., **a** and **b** quantities in minutes, position angle; the same data for each standard station westward.

Longitudes and latitudes of standard stations are: **A** +72°.5, +42°.5; **B** +73°.6, +45°.5; **C** +77°.1, +38°.9; **D** +79°.4, +43°.7; **E** +91°.0, +40°.0; **F** +98°.0, +30°.0; **G** +114°.1, +51°.0; **H** +120°.0, +36°.0; **I** +123°.1, +49°.3. The **a** and **b** quantities are variations of standard-station predicted times per degree of longitude and of latitude respectively, enabling computation of fairly accurate times for one's local station (long. **Lo,** lat. **L**) within 200 or 300 miles of a standard station (long. **LoS,** lat. **LS**). Multiply **a** by the difference in longitude (**Lo — LoS**), and multiply **b** by the difference in latitude (**L — LS**), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Greenwich civil time to your own standard or war time.

For additional occultations consult the **American Ephemeris and Nautical Almanac** and the British **Nautical Almanac,** from which these predictions are taken. Texas predictions were computed by E. W. Woolard and Paul Herget.

MR. FITZPATRICK DIES

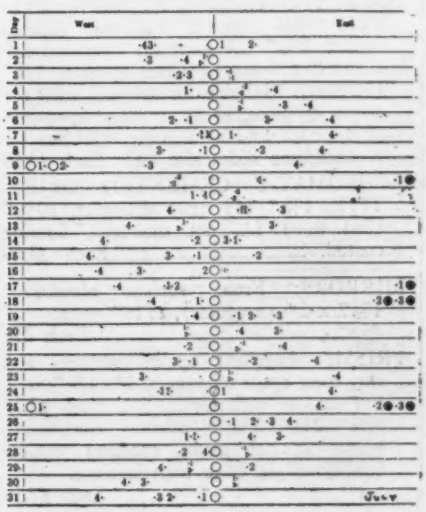
Word is received just as we go to press of the death on June 6th of Jesse A. Fitzpatrick, the editor of this department, in New Rochelle Hospital after an illness of some months.

Since January of 1941, Mr. Fitzpatrick has been a faithful contributor to this magazine, preparing his copy well in advance and covering a wide variety of observing subjects. His lifetime interest in astronomy made him many friends throughout the country.

On the part of our readers and ourselves, we wish to acknowledge with deep appreciation Jesse A. Fitzpatrick's countless hours of devoted service in these last four and one half years. THE EDITORS

JUPITER'S SATELLITES

Jupiter's four bright moons have the positions shown below at 10:45 p.m. on the day preceding the date shown. The motion of each satellite is from the dot to the number designating it. Transits of satellites over Jupiter's disk are shown by open circles at the left, and eclipses and occultations by black disks at the right. From the **American Ephemeris and Nautical Almanac.**



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PLANETARIUM NOTES

Sky and Telescope is official bulletin of the Hayden Planetarium, 81st Street and Central Park West, New York City, and of the Buhl Planetarium, Federal and West Ohio Streets, Pittsburgh, Pa.

★ **THE BUHL PLANETARIUM** presents, *July 1st through 9th,* PREVIEW OF THE JULY ECLIPSE.

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★ **THE HAYDEN PLANETARIUM** presents in *July,* SUMMER STARS. (See page 12.)

In *August,* TRIP TO THE MOON. Have you not sometimes watched the moon, perhaps observing its mountains and valleys through opera glasses or binoculars, wishing that you yourself might for a brief moment stand upon the surface of that strange world? Here is your opportunity. During the month of August you can find out for yourself what life on the moon would be like. What is the weather? What about your weight? Why would the sun always appear against a spangled backdrop of stars? Travel to the moon this month in the Hayden Planetarum rocket ship—you'll come home with tall tales of an astronomical odyssey.

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By ALLYN J. THOMPSON

Field of view. A single plano-convex lens, used in the telescope as an eyepiece, or ocular, and held with the plane surface toward the eye, will give nice definition, but only over a very small field. One reason for the small field will be found from a study of Fig. 35. Suppose such a lens of 1" focal length were substituted for the compound eyepiece of 1" equivalent focal length shown in that diagram. As the single lens would have to be placed about one inch from the focal plane FP, the outer rays from the objective would miss it entirely, thereby narrowing the field. And because of the many inherent defects that are present in a single lens, a diaphragm would have to be used, which would further reduce the field. These defects, which are partially or wholly corrected in the two-lens oculars, are described as spherical aberration, distortion, coma, curvature of the field, chromatic aberration, chromatic difference of magnification, and astigmatism. Since these errors are increased with the distance from the center of the field, it can be realized that the problem of increasing the useful field of view becomes a difficult one. As Bell says in **The Telescope**, the size of this field depends on the amount of aberration that can be tolerated. Probably not larger than an apparent field of 15° can be had with the single-lens ocular.

The 1" Ramsden eyepiece described last month will probably have its field lens of .7" clear aperture. As we can find from reviewing Fig. 21, this ocular will take in a **real field** of view of 50 minutes in a 6-inch f/8 telescope. Multiplying this by 48, the amount of magnification obtained, gives us 40°, the apparent size of the field seen with that ocular. This is what is meant in speaking of **apparent field.** Conversely, if we divide the magnification into the apparent field of the eyepiece, we obtain the real field of view. We see, therefore, that as magnification is increased, the real field of view becomes smaller.

On the other hand, we can increase the size of the field by the use of low-power eyepieces having larger field lenses. Of course, in order to provide full illumination over this larger field, a larger diagonal would have to be used, and the tube diameter increased as well.

Suppose we have an eyepiece of 3" e.f.l., giving a magnification of 16 with a 6-inch f/8 telescope, having an apparent field of 40°. Its field lens will be about 2" in diameter, and it would take in a real star field 2½° in diameter. But stars fainter than 12th magnitude could not be seen, for the following reason: The mirror receives from each star a 6" cylinder of light, which converges to a point image; thence this diverges and enters the eyepiece, emerging in a condensed cylinder or beam of light, called the exit pupil, or Ramsden disk. The size of this exit pupil is in the same ratio to the diameter of the mirror as the focal length of the eyepiece to that of the mirror, which ratio is here 1/16 (the reciprocal of the magnification), so the eyebeam is almost 9½ mm. in diameter. Since the pupil of the eye opens, at night, to not much over 7 mm., all of the original light from the star cannot enter the eye. The part of the mirror outside of an area about 4½" in diameter is, in effect, diaphragmed out by the limiting size of the pupillary opening. We will find that the lowest-power eyepiece that can be used with the mirror, and at the same time employ full aperture, is one of 2¼" e.f.l. This is a magnification of about 3½ per inch of aperture, and is about the lowest magnification that should be used on any telescope.

A practical example is the 7 x 50 binocular which is standard equipment in the U. S. Navy. This is the so-called night glass, most useful in the deepening twilight. It is a 7-power glass, with 50 mm. (2 inch) objectives. The exit pupil is, therefore, 7 mm. in diameter, quite filling the expanding pupillary opening in the dim light.

If you are uncertain of the focal length of an ocular, it may be found quite accurately in this manner. Focus the telescope on a distant object, then point it to the daylight sky. Place the eye about 10" back of the eyepiece, and a bright round disk of light will be seen; this is the Ramsden disk. Measure its diameter exactly, with a fine scale held in the plane of the Ramsden disk, using

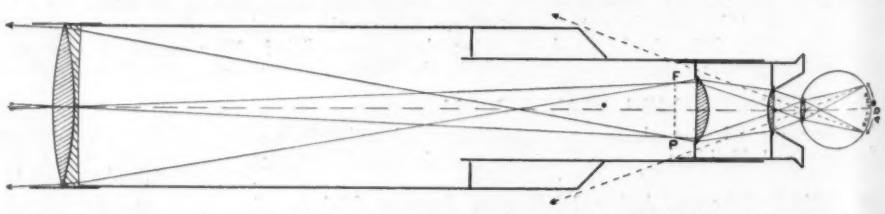

Fig. 35. The optical system of a small refractor, such as a finder, of 8" focal length; its 8x eyepiece has an apparent field of 40°, but the real field of view is 5°. This diagram is 13/32 of the instrument's actual size.

a magnifying glass to get an accurate reading. Dividing the value obtained into the diameter of the mirror gives the magnification, which, divided into the mirror's focal length, gives the focal length of the ocular. Other methods of measuring eyepiece focal lengths are described in **Sky and Telescope**, 36, 16, October, 1944.

The Ramsden disk is actually the image of the mirror projected by the eyepiece, and in examining it with the magnifier, the image of the diagonal will be seen sharply outlined against it.

When taking his first look through the telescope in completing the adjustments described in VIII, the amateur may have been troubled by the conspicuous shadow of the obstructing diagonal, especially if a low-power eyepiece had been used at the time. Of course, he was pleased, and perhaps mystified, to find that the objectionable obstruction was not apparent at night.

The mystery clears up when it is seen that the image of the diagonal, as seen in the exit pupil of the low-power eyepiece, may be nearly as large as the pupillary opening of the eye in the bright daylight. At night the obstructive shadow becomes unnoticeable with the greatly enlarged pupil. In daylight or terrestrial observation, high-power eyepieces should be used.

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X — THE MOUNTING

Everyone is more-or-less familiar with the surveyor's transit, in which two bearings at right angles to each other enable the telescope to be pointed to any spot in the celestial dome. The motions are one in azimuth, about the perpendicular axis, and one in altitude, about the horizontal axis. The names of these motions have been combined in the term altazimuth, which is used to describe this type of mounting. If the telescope is swung through 360° in azimuth, the field of view will traverse an orbit about the zenith, whereas the stars, in their daily or diurnal motion, describe orbits around the celestial pole.

However, if we tilt the instrument so that the perpendicular axis points to the celestial pole, instead of to the zenith, the formerly horizontal motion will exactly follow the paths of the stars. In this position it is called an equatorial mounting. What was the azimuth motion has become one in right ascension, and its axis is called the polar axis. The former altitude motion is now one in declination, turning on the declination axis.

When the telescope is mounted in this way, objects too faint to be seen with the eye can be easily found. Suppose we wish to view the planet Neptune, assuming it to be above the horizon. We find its position (right ascension and declination) in the **American Ephemeris.** We swing the telescope on the declination axis so that it points the required number of degrees north or south of the celestial equator, and clamp it. Then we swing the telescope on the polar axis until the correct hour angle is read on the hour circle, and Neptune should be in the field of view. Of course, this procedure is possible only on an accurately adjusted telescope, equipped with setting circles, and if the sidereal time is known or computed for the time of the observation.

There is one feature that must be emphasized in the design of a telescope mounting, and that is rigidity. Nothing is as abominable and useless as a telescope which trembles in the slightest breeze. Take a stick from a fire and whirl its glowing end before the eye in all sorts of gyrations. That is what the image of a star looks like in a weakly mounted telescope. Remember that any shake or vibration is amplified by the magnification being used, and what may appear to be quite a stable instrument may not prove so when trying to observe the Cassini division in Saturn's rings with a ½" eyepiece. Large size, smoothly operating bearings, well-fitted parts, and a sturdy support are required in a well-built mounting.

There is too great a latitude in ideas and design in telescope mounts for the subject to be entered into here. (For a discussion of mounting types see **Sky and Telescope**, 26, 16, December, 1943.) Our primary objective is to enable the amateur to mount his telescope cheaply and efficiently. What will be described

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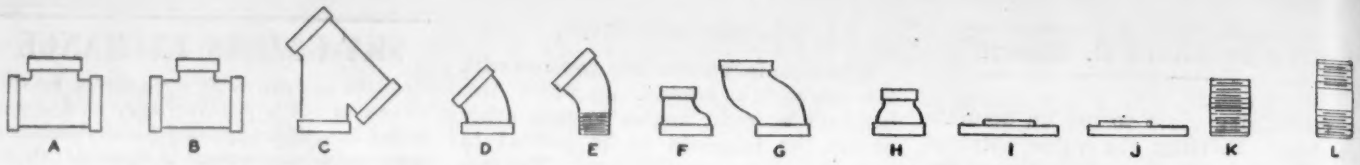


Fig. 36. Useful pipe fittings: A. Tee; B. Reducing tee; C. Wye or lateral; D. 45° elbow; E. 45° street elbow; F. Eccentric reducer coupling; G. Offset coupling; H. Reducer coupling; I. Heavy flange; J. Offset flange; K and L. Nipples.

is a conventional form of mounting, known as the German type, utilizing pipe fittings, which are admirably adapted to the purpose. Study of the construction will be of aid to those fortunate ones who are able to design their own castings. The pipe fittings are obtainable in iron or brass at any steamfitters or plumbers supply house. Useful fittings are illustrated in Fig. 36.

Shown in Fig. 37 is a fixed pipe mount in which the polar and declination axes turn on the threads of the short nipples L. The fittings are 3" pipe size, and can be identified from Fig. 36. The height of A above the ground should be such that the eyepiece is at a comfortable height when the tube is pointed to the zenith. For better bearing action, the threads of the polar and declination axes should be lapped in. Paint the threads with a mixture of #220 Carbo and cutting oil, and screw the tee, or flange, on and off, grinding away until a couple more threads are engaged. Clean out all grit with a stiff brush and kerosene oil, then add lubricating oil. A much smoother turning action will be the result. No machining is required. The counterweight may be of iron, lead, or concrete.

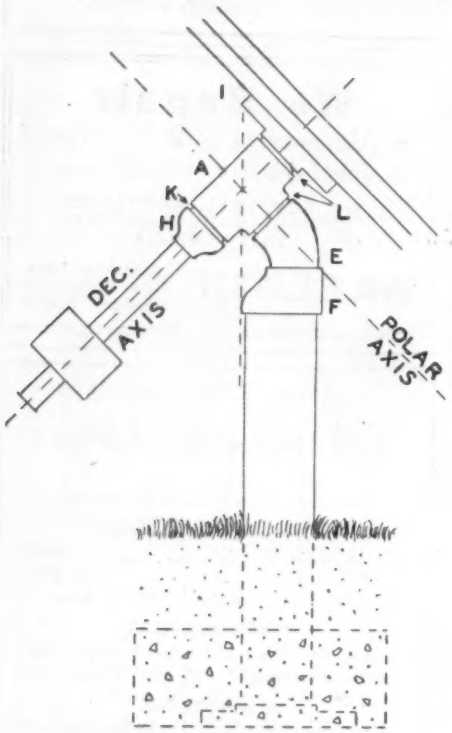


Fig. 37. Pipe mount (first type). The axes turn on threads of the close or short nipples, L. Other parts can be identified from Fig. 36. The eccentric reducer F is used in an effort to bring the center of gravity over the pier; failing this, the base of the the pier has been eccentrically cast in the concrete block.

Another design is shown in Fig. 38; 1½" pipe and fittings are preferred. The lengths of pipe which make up the polar and declination axes are turned perfectly round in the lathe, taking the minimum cut for the purpose. The internal threads of the tees are bored out so that the trued-up pipe will just fit snugly into them. The faces of the tees ought also to be machined.

A third and perhaps the most satisfactory way of employing pipe fittings is shown in Fig. 39. In this design, 1" pipe is used for the axes, with 1½" fittings, and the intervening space is filled with Babbitt metal. This gives a very smooth, rigid bearing, and it is possible in the construction to align the axes perpendicular to each other with great accuracy.

For the permanent mount, where weight is not a factor, 1⅜" solid bar stock is preferred to pipe, which must be machined perfectly round in the lathe. Bar stock is truly round, and it is only necessary to have the local plumber cut the pipe thread on it. Be sure the vise jaws do not grip that part of the shafting that is to be encased in Babbitt, as the resultant dents will cause trouble. 1⅜" machined collars can be purchased at the hardware store.

First, drill three holes radially, near each end of the tee and wye (Fig. 40), for #8-32 screws which will be used to center and support the shafting in the fittings while the Babbitt is poured. Make up the polar axis tight in tee E. It will have to be removed later, so in order that it may again be returned to the same exact position drill a hole through the branch opening of the tee into the shafting. When finally assembled, a pin or screw should be inserted here. Slip the collar into place, snug against the tee.

Now smear the polar axis and the collar with a mixture of thin lubricating oil and lampblack, to prevent the Babbitt sticking to the metal.

Place the polar axis in the wye fitting, with its collar bearing against the upper face of the wye, and carefully center it with the set screws. To prevent the molten Babbitt from running out, fit an asbestos paper or thin sheet-metal collar over the other end and seal up any gaps with putty. One or two pinhole perforations in the collar will permit the escape of air. Brace the assemblage so that it cannot roll during the pouring operation.

Make a trough of the asbestos paper or thin sheet metal, support it in the branch opening of the wye so that the Babbitt, when poured, will not land directly on the shafting (Fig. 40). Quickly pour in the molten Babbitt until the shafting is well covered. When it is cool, some effort may be required to free the shafting.

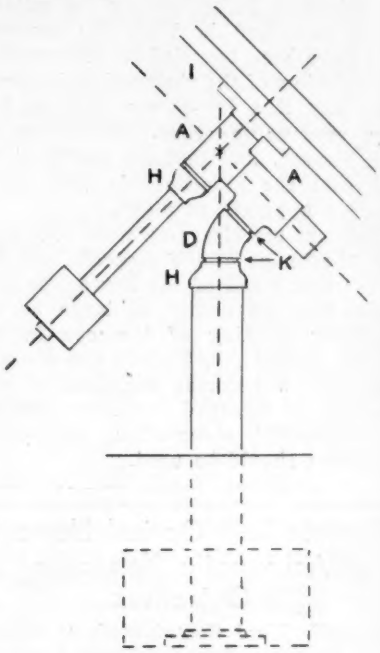


Fig. 38. Pipe mount (second type), of which Fig. 47 is an example. The pipe sections which comprise the polar and declination axes have been turned accurately round in the lathe, and rotate smoothly in the bored-out tees. In this design, the center of gravity has been brought over the center of the pier, and no counterweight is needed on the polar axis. Parts can be identified from Fig. 36.

Make up the declination axis tightly in the heavy flange K, and slip one collar over it, up against the flange. Smear shaft and collar with the lampblack and oil, then put it into the tee of the polar axis, which is still encased in its bearing. Put on the other collar.

Some means of adjusting the two axes perpendicular to each other must now be found. The success of the final adjustments is dependent on the accuracy of this setting, so take plenty of time with it. It cannot be corrected after the Babbitt has been poured. One way is to rig up a pointer on the wye, contacting the declination axis at some point, then turn the polar axis through 180° and see if the pointer again con-

tacts the declination axis. By repeated trials, and adjustment of the supporting set screws in the tee, a very accurate setting can be arrived at.

Carefully, now, so as not to disturb the setting of the declination axis, unscrew the polar axis from the tee. Support the declination axis assembly, and pour in the Babbitt through the branch opening.

When cool, remove both axes from their bearings, and drill and tap for the 5/16" clamping screws L. In order that the shafting will not be scored by these screws, cut small round plugs from thick leather and insert them into the holes to cushion the thrust.

Screw the polar axis back into the tee, and pin it securely in its original position; return both axes to their bearings, and the mounting is complete.

The amateur who has access to a lathe will, no doubt, contrive to machine the faces of the tee and wye, and so effect smoother performance. With careful planning of the whole operation, they can be made square with the axes. Added refinements, which are left to the worker's discretion, are a worm-and-gear slow motion on the polar axis, and either a rack-and-pinion or a multiple-thread focusing arrangement on the eyepiece adapter tube.

Note the provision for making latitude correction in Fig. 39. It will pay to take a little time in accurately setting the four bolts (only three are visible in Fig. 39) in the concrete pier, as adjustment will be greatly simplified if they are exactly oriented. A method for locating true north is given in XII.

Accompanying Fig. 39 is a table listing sizes and descriptions of parts for both permanent and portable mounts. A 45° elbow and a tee, used as in Fig. 38 instead of the wye, is preferred for the portable mount, as it dispenses with the counterweight on the polar axis. The wye is more rigid, however, and so is preferred for the fixed mounting.

A fair amount of machining is necessary for the construction of the portable mounting, so unless the amateur possesses a lathe, or is prepared to pay for having the work done, he had better forego this type of mounting. The various operations will not be discussed here, as the skilled machinist can quickly plan the work. To effect a weight reduction, the collars may be made of aluminum stock.

As the difference in cost is little, brass fittings are to be preferred. Brass is easier to machine than iron, will not rust, and has a more pleasing appearance. Also, the inside surfaces of the brass fittings can be tinned, thereby providing a secure anchor for the Babbitt.

Standard weight pipe, 1" and 1¼" fittings, are recommended, but if the weight feature is of paramount importance, recourse may be had to the next smaller sizes, in which case extra-strong pipe, having thicker walls, should be used. Needless to say, a sacrifice in rigidity is to be expected. The pipe will, of course, have to be turned perfectly round in the lathe, first centering each piece carefully so that a minimum cut will be required to true it. The collars will have to be specially made and should be equipped with set screws.

KEY TO FIG. 39, AND SPECIFICATIONS OF PARTS FOR MOUNTINGS

		Fixed Mount	*Tripod Mount*	*Light Portable*
A	Heavy flange	1½"	Tripod head	Tripod head
B	Lock nuts		none	none
C	Wye	1½ x 1½ x 1½	Use design of Fig. 38,	Elbow & Tee
			1¼" Elbow	1" Elbow
			1¼" Tee	1" Tee
D	Close nipple	1½"	1¼"	1"
E	Reducing tee	1½ x 1½ x 1	1¼ x 1¼ x 1	1 x 1 x ¾
F	Length of pipe	1", 9" long	1", 8" long	¾", 8" long
G	Reducers	1 x ¾	1 x ¾	¾ x ½
H	Extension pipe	¾", 12" long	¾", 12" long	½", 12" long
I	Counterweight	Two	Dec. axis only	Dec. axis only
J	Collars, machined to size, equipped with set screws			
K	Heavy flange	1"	1"	¾"
L	Clamping screws	5/16"	5/16"	¼"
M	Setting circles and pointers		none	none

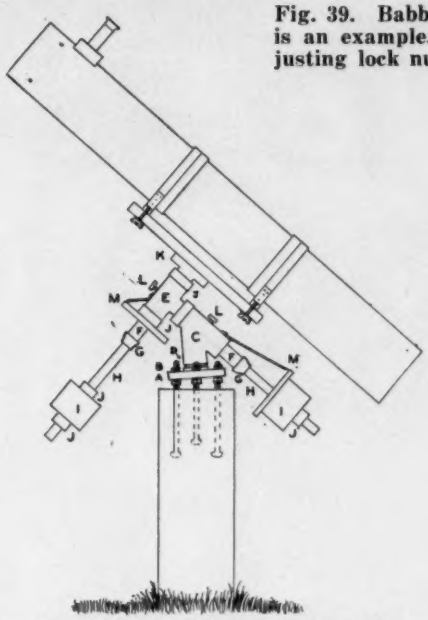


Fig. 39. Babbitted bearing pipe mount, of which Fig. 46 is an example. Altitude correction can be made by adjusting lock nuts B; azimuth correction by rotating C on close nipple D.

On account of the small difference in size between the pipe and the fittings, the internal threads of the fittings will have to be bored out to make room for the Babbitt. Do not forget to apply the oil and lampblack mixture to the pipe before babbitting.

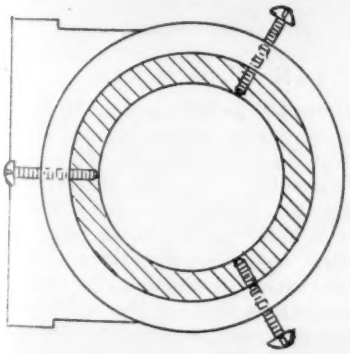
In screwing the pipe into the fittings, which may be done in order to machine both together, do not use the wrench jaws on any part of the pipe which will be encased in the Babbitt.

SPECIFICATIONS OF STANDARD PIPE SIZES*

Size (inches)	Outside diameter	Inside diameter	Nominal wall thickness	No. threads per inch	Depth of thread
⅛	.840	.546	.147	14	.0571
¼	1.050	.742	.154	14	.0571
1	1.315	.957	.179	11½	.0696
1¼	1.660	1.278	.191	11½	.0696
1½	1.900	1.500	.200	11½	.0696
2	2.375	1.939	.218	11½	.0696
2½	2.875	2.323	.276	8	.1
3	3.500	2.900	.300	8	.1
3½	4.000	3.364	.318	8	.1
4	4.500	3.826	.337	8	.1

*In speaking of pipe size, the dimension is always referred to the **inside diameter of standard weight pipe**; for example: 1" pipe, whether of standard, heavy, or extra-heavy wall thickness, has the same nominal outside diameter: 1.315".

(To be continued. Next month, a tripod mounting; setting circles.)



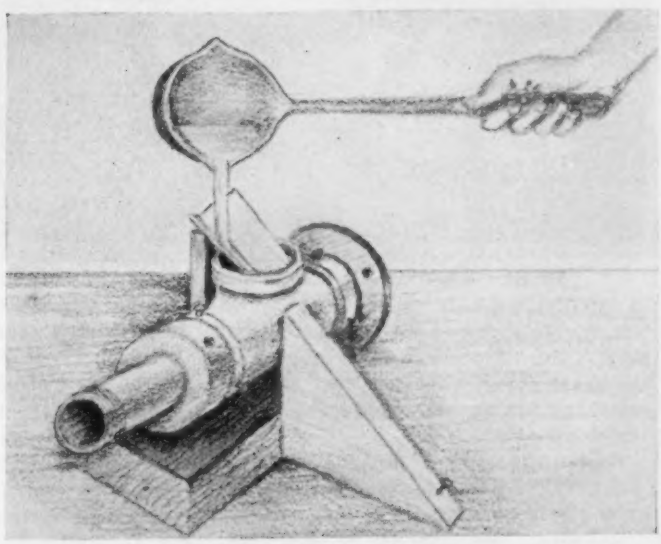
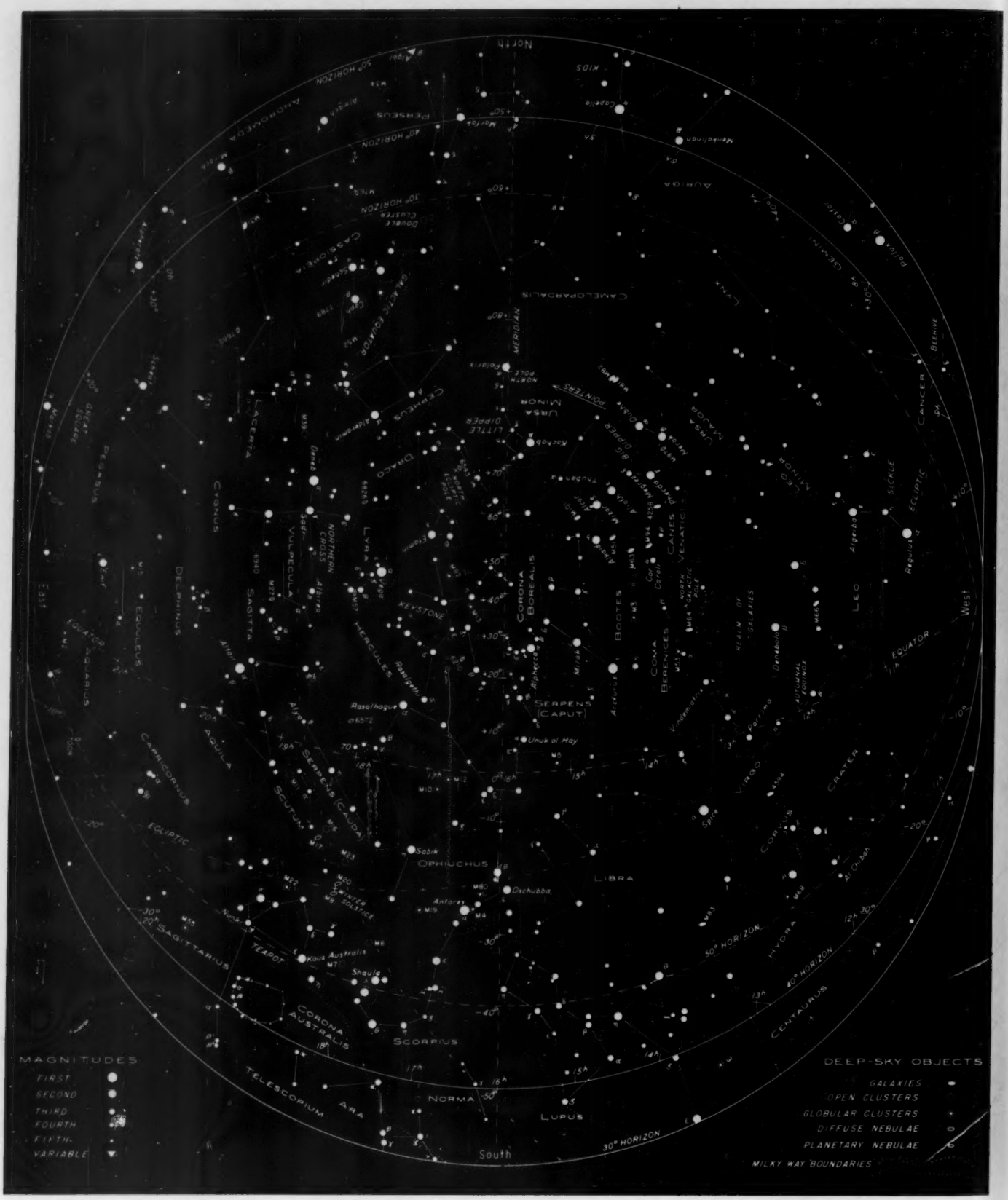


Fig. 40. (Left) How shafting is centered in the tees for babbitting. (Right) Pouring the Babbitt for the declination bearing.



DEEP-SKY WONDERS

AMONG marvels for observation in the July skies are the objects listed here, some of which are not shown on the chart above. The informal descriptions are for common telescopes. Norton designations are in parentheses.

Coma Berenices. M64, 12h 54m.3, +21° 47′; spiral galaxy; a dim oval, with starlike center.

Scorpius. M6, 17h 33m.5, —32° 09′; cluster of 50 stars. Near M7, a larger cluster, also of 50 stars.

Serpens Cauda. NGC 6633 (72s), 18h 22m.7, +6° 30′; cluster of 65 stars, bright, wide-scattered.

Scutum. IC 4756 (2017h), 18h 34m, +5° 22′; a large cluster of 80 stars.

Ursa Major. M101 or NGC 5457, 14h 1m.4, +54° 35′; large, dim galaxy, over the handle of the Big Dipper.

L. S. COPELAND

STARS FOR JULY

from latitudes 30° to 50° north, at 10 p.m. and 9 p.m., war time, on the 7th and 23rd of the month, respectively. The 40° north horizon is a solid circle; the others are circles, too, but dashed in part. When facing north, hold "North" at the bottom, and similarly for other directions. This is a stereographic projection, in which the flattened appearance of the sky itself is closely reproduced, without distortion.

EVENING STARS FOR SOUTHERN OBSERVERS

THIS is the seventh map in the series of star charts for use by observers in the Southern Hemisphere, and matching the northern maps. It is prepared for a basic latitude of 30° south, but may be used conveniently 20 degrees on either side of that parallel. These southern charts appear in alternate months, but always two or three months in advance, to allow time for transmission to observers in any part of the world. When 12 charts have been produced, and if interest warrants, a special edition of **Sky and Telescope** may be published each month carrying observing material for Southern Hemisphere observers. This chart is for use in latitudes 20° to 40° south on Sept. 7th at 11 p.m., Sept. 23rd at 10 p.m., October 7th and 23rd at 9 p.m. and 8 p.m., respectively. Times for other days vary similarly: four minutes earlier per day. These are local mean times which must be corrected for standard time and war time differences. The 30° horizon is a solid circle; the other horizons are circles, too, those for 20° and 40° south being dashed in part. When facing south, hold "South" at the bottom, and similarly for other directions. Observers in the tropics may find north circumpolar stars on any of our northern star charts.